NATURE

No. 4433 SATURDAY, OCTOBER 16, 1954 Vol. 174

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Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
W. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

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MASS COMMUNICATION, POWER AND INFLUENCE

NOW that the Television Act is on the statute book and the chairman and director-general of the Independent Television Authority have been appointed, it should be possible to continue the public discussion of the real issues free from the heat engendered by the decision to make commercial television a party political matter. The composition of the governing body of the Independent Television Authority encourages confidence that every effort will be made to see that the development of television is fostered with due regard to the public interest, though it has yet to be seen whether in practice the high standards of public service established by the British Broadcasting Corporation can be maintained. Meanwhile, it should be apparent that the misgivings which are entertained on that score are due not to poor opinions of business interests or of advertisers, but rather to doubts whether the Authority possesses sufficient powers and independence to make the public interest prevail if a clash with commercial interests should arise. To insist that the public interest must prevail, or that the question of what is the public interest is not to be determined by those whose interests are immediately concerned, is no more to impute bad faith to such persons than to maintain that government departments should not be left to judge the public interest in matters in which they are immediately concerned is to impeach the integrity of the Civil Service.

It is only too easy to attack the motives of those whose belief that broadcasting and television represent instruments of immense power over the minds of men, the social and economic implications of which are not yet apparent, leads them to urge that both broadcasting and television should be treated in the same way and on the same plane as questions of education and other matters which profoundly affect the life and thought of whole communities. When the dust of party political conflict has subsided, attacks on the integrity of men like Lord Halifax and Lord Waverley, for example, can be seen for what they are worth; and the genuineness of the concern of such men that television and broadcasting may profoundly affect the character of our people for good or ill is unquestionable. It is indeed the belief that we need all the help we can get from this new instrument, of which science has made us masters, that has led to such stress being laid on the principle of public service—the principle that such power should be exercised responsibly for the public good. Broadcasting and television are necessarily and above all, as the Archbishop of Canterbury said in the debate on July 1, instruments of education. They provide ideas and information in such a way as to evoke, create, and contribute to mental, moral and spiritual reactions in the hearer or viewer. As with the cinema, their function as entertainment cannot be separated from this process of stimulus and reaction, even when it amounts to no more than passive acceptance. Indeed, the gravest

danger of television appears to be that, instead of encouraging the process of education, it will foster a sluggish torpidity of mind which will render many incapable of being educated at all.

Even so, it would be going too far to consider the system created under the Television Act solely or even primarily as an educational instrument, though that aspect cannot be disregarded in considering any aspect of the system. What needs to be remembered is that this is a matter of influence, not of power, and its effect should be considered along with that of such other public influences as the Press and the cinema, and not in isolation. Failure to do so has encouraged the mistaken belief that the British Broadcasting Corporation possesses great power, whereas in fact it possesses little or no power but great influence.

Even the summary of the report of the Drogheda Committee* of inquiry into British Overseas Information Services, which the Government published last April, should help to remove that belief and to put broadcasting in its proper perspective as a vehicle for the communication of ideas and information. The Drogheda Committee could not avoid the conclusion that a modern government has to concern itself with public opinion abroad and be properly equipped to deal with it, and it followed accordingly that overseas information services play an important and indeed an essential part in support of foreign, Commonwealth and Colonial policies. The report faces fairly and squarely the implications of propaganda and counter-propaganda as a means of influencing public opinion in other countries, which the development of methods of mass communication has made possible.

It is obvious from the Government's treatment of the report, and the negative attitude which the Government spokesman, Mr. H. A. Nutting, had to reveal, particularly his denunciation of co-ordination, in the debate on July 6, that some, at any rate, of the findings of the Committee, and particularly its recommendations for a concerted and long-term policy, are unpalatable. But to the impartial observer, those findings, on the evidence published, are the more impressive because of the moderation with which they are presented. The case is not over-stated. Although the need for official information services is argued convincingly, it is never suggested that propaganda is a substitute for policy or for military strength, economic efficiency or financial stability. Its effect on the course of events is unlikely to be more than marginal; but in certain circumstances it could be a decisive factor in determining diplomatic success or failure. Even in this supplementary role, it can, however, make a contribution of outstanding importance to the efficiency with which Great Britain's resources are used to further policy.

The Drogheda Committee presents a case for the support of overseas information services, including broadcasting, with adequate resources for objectives which are broadly but clearly defined. No attempt has been made to refute that case, or to deny the Committee's assertion that the resources at present provided are entirely inadequate to meet those purposes. The increased expenditure of some two million pounds recommended by the Drogheda Committee, bringing the total to some twelve and a half million a year, is insignificant in comparison with its importance to the military and economic strength of Britain, and any political party which shirks finding the necessary funds because unpopular economies are involved elsewhere is clearly guilty of dereliction of public duty.

The published summary of this report shows how carefully the Drogheda Committee examined broadcasting as a means of influencing public opinion in relation to other means of promoting an understanding of the British way of life and point of view, such as books, periodicals and newspapers. It is admitted that it is difficult to assess the effectiveness of any information service, whether spoken or printed, and that broadcasting as a means of influencing opinion is always in danger of falling between the two stools of the mass audience and the influential minority. Nevertheless, the Committee holds that the high reputation of the British Broadcasting Corporation External Service for objective and honest news-reporting is a priceless asset which sets that service apart from all other broadcasting systems. This high reputation for objectivity must be maintained at all costs, and the concern with which the Government's attitude to commercial broadcasting and television is regarded arises, at least to some extent, from the belief that the Government is unwilling to put at the disposal of the new Authority sufficient resources to make it independent of influences which could destroy that objectivity.

It is perhaps unlikely that any attempt will be made by the Government to use the British Broadcasting Corporation for anything in the way of direct propaganda; but, apart from indirect effects which commercial broadcasting might have, and also commercial television, measures which entail financial stringency threaten more than the scale of the Corporation's factual presentation to other countries of the news and of British views concerning the news. The Government must make up its mind either to provide sufficient support for overseas information services to enable them to be planned as a whole on a long-term basis, safeguarded against the changes which destroy efficiency, or see that the British Broadcasting Corporation itself is provided with sufficient resources to provide the services required without risk of their magnitude or content being subjected to sectional interests or pressure. Once the reputation for objectivity is lost or the opportunities for presenting the British point of view are missed, they are not easily recovered.

These related problems are internal as well as external, and they were considered by Sir William Haley in the Clayton Memorial Lecture delivered before the Manchester Literary and Philosophical

* Overseas Information Services. Miscellaneous No. 12 (1954): Summary of the Report of the Independent Committee of Enquiry into the Overseas Information Services. Pp. 56. (Cmd. 9138.) (London: H.M. Stationery Office, 1954.) 1s. 9d. net.

Society last March*. That penetrating lecture, on the theme of the part which the Press and broadcasting play in building up public opinion and thus, in a democracy, in shaping public policy, deserves to be read widely. It is a valuable contribution to the clear thinking which is required on the problems arising out of the interplay of the means of information, education and entertainment in the world to-day and their bearing on wise government. The reception of the Drogheda Report itself is sufficient evidence of the dangers which arise if a government feels itself insufficiently secure to take steps imperative in the public interest because to do so may involve other unpopular measures the necessity for which could not perhaps be clearly explained to the public in the conditions of party political debate.

What Sir William Haley said bears closely on this vital matter of securing an alert, informed and intelligent public opinion. First, he explained the difference in the nature of broadcasting and the Press. Apart from its comparative novelty, though geographically the most pervading form of communication yet devised, broadcasting has limitations. Compared with the Press, it is comparatively inaccessible, being limited by time both in range and in space. Against the advantage of immediacy, especially on great occasions, has to be set its complexity and comparative inflexibility of operation compared with the Press. The Press, said Sir William, is far freer and less inhibited in political matters: because each individual reader can comprehend its output, a newspaper can have an impact which no broadcasting station can possess. It is not merely free to have a policy, an attitude, a way of thought: it can also make these things felt. Moreover, the printed word is more enduring than the spoken word, and while much of the best broadcasting is aimed at the emotions, most of the best journalism is aimed at the head.

Sir William Haley here makes a point which has received little attention in the debates over television and broadcasting of the past few years. The limitations to which he refers arise not out of the nature of the British Broadcasting Corporation and its monopoly; they apply to any system of broadcasting and are inherent in the nature of the medium. The use we make either of broadcasting or of television and the influence they exert in our own or any other community depend not only on technique and on the way in which we use them, but also on the nature of the medium. Ultimately, practical and physical considerations must determine what is done, and Sir William's comments on television in this connexion are shrewd and disturbing.

He emphasizes what is often overlooked—that over the programme field as a whole television, from its nature, cannot have the same range as sound broadcasting. Moreover, although television robs broadcasting of the great stimulus of the listener's imagination, for whole sections of the population television threatens to become the whole of broadcasting. Because thereby passivity instead of co-operation is encouraged, the whole educational purpose of broadcasting is at stake.

This is true whatever the outcome of the struggle between the idea of public purpose and commercial interest in television and broadcasting, and the picture Sir William gives of how much is at stake, particularly in politics and news, is disturbing. He pays a tribute to the way in which in the past the combined wisdom of Parliament, of the early committees on broadcasting, of the political party leaders and elder statesmen in both Houses of Parliament and of responsible directors and governors of the British Broadcasting Corporation, have given us a panoply of political broadcasting which has led the nation to be informed, persuaded, fairly exhorted, and given the requisite facts or opinions upon which to make up its mind, while simultaneously defending it against irresponsibility, demagogy and abuse. These same experienced forces, he believes, will bring wisdom and judgment to bear on the use of television, but they cannot ignore the nature of the medium with which they are working; and Sir William regards the coming of the television screen into every home, and the visual presentation of political affairs and politicians in this way, as a major sociological influence of our time.

Sir William Haley is disturbed because much news, particularly the most significant and important news, has no visual quality. The nature of the medium, accordingly, is likely to be continually at war with the real values of the news, and though he is confident that the B.B.C. will make an imaginative, courageous and thoroughly honest attempt to reconcile this conflict, he is less confident as to the outcome. On its outcome the future influence of both broadcasting and the Press may well depend; but it is difficult to feel as sure as Sir William that if the televized news bulletin proves a failure, the ordinary man or woman will revert to the printed word. There is the effect of television on the viewer, on education, and on literacy to be considered. Lord Reith was right at least in asserting that in the Television Act social, political, intellectual and ethical issues of incalculable gravity are at stake. He did not believe that its supporters would wittingly or willingly suborn moral responsibility or do moral hurt to their country at any one's dictation; but he may not have been so very wide of the mark in suggesting the possibility that the Government has surrendered a fundamental principle, moral values and intellectual and ethical objectives that should be cherished.

The reality of such dangers appears more clearly as we reflect upon Sir William Haley's observations on the inter-relations of the Press and broadcasting and the way their influence is exerted in the society of to-day. He believes that the Press still has great influence, but the character of its influence has changed; it is now not so much political as informative and interpretative, and while the great masses of the people may, as Sir William suggests, eschew opinions on the bewildering range of our manifold problems to-day and leave it to their repre-

* "The Public Influence of Broadcasting and the Press". By Sir William Haley. (Clayton Memorial Lecture.) (Manchester: Literary and Philosophical Society, 1954.)

sentatives, we cannot entirely ignore the outlook and opinions of the general population. The serious Press is undoubtedly able to inform those representatives on hosts of important matters, and has sources of information and of informed judgment which in total are not available to the ordinary member of Parliament and can often supplement the knowledge of Ministers. Its influence on serious public opinion can be powerful, constructive, widespread and continuous.

Nevertheless, leaders of thought and action inside and outside Parliament, those of all classes in industry, the universities and schools, the professions, the churches and every walk of life who take an intelligent interest in events, still form only a fraction, though probably a greater part than formerly, of the nation. As voters in the electorate their influence could be ineffective, and Sir William Haley is clearly disturbed that the national temper may be such that the judgment and wisdom of the informed minority may fail to avert disaster. The symptoms and tendencies which he notes, moreover, may well be fostered as television encourages further both passivity and the expectancy that the individual can and should receive everything of the nation without contributing in return.

Sir William's own conclusion is not too pessimistic. He says quite frankly that certain daily and weekly newspapers with huge circulations among the less discerning and discriminating section of the community are indirectly and cumulatively building up an attitude of mind in the new generation which can be disastrous unless it is counteracted, and he points out that the Press has missed some opportunities which broadcasting has given it; but he recognizes that much of the Press has done and is doing fine work. He regards the Press and broadcasting as complementary, not inimical to each other. The Press, he suggests, could have concentrated on what broadcasting could not at one time do, namely, providing the background, explanation, opinion, exegesis and illustration, and maintaining a sense of values.

It does not appear, however, that Sir William is over-confident that should television take over the major part of the broadcasting audience and the televized news bulletins prove a failure, the popular Press will return to its proper role and again become an educative force. That might happen, he thinks, under the influence of public opinion, and he reminds us of the short time since we created a nation that can read. We have yet to make it a literate nation; whether television will assist or hinder that step remains to be seen.

Sir William suggested in this lecture that the most significant influence of the popular Press is now on what he calls morals, whereas the influence of British broadcasting has been mostly on manners. That influence could equally continue in television, but the arguments against commercial television indicate that widespread doubts are entertained as to whether in such a context television or broadcasting can raise standards of conduct or taste, or even maintain them. However that may be, Sir William's contention that the Press as well as broadcasting should resume their role as leaders rather than followers of public opinion is indeed timely. Unless they remain true to their earliest ideals and seek to guide and uplift and not debase public opinion, we are on the way to an essentially uneducated nation, with all that is thereby implied in the abandonment of democracy and the growth of regimentation and intolerance.

What needs to be emphasized is that for the Press, no less than for broadcasting and television, the educational purpose cannot, without danger to the whole basis of the British way of life, be subordinated to the entertainment function. The two purposes must be harmonized and reconciled, but it must not be by the abdication of leadership and the disregard of the responsibility for the accurate and fair presentation of facts, opinions and events. Sir William Haley denounces rightly as humbug and nonsense the doctrine that the public should be given nothing but what it wants, and that any design to give it or to lead it to want something better is highly dangerous and anti-democratic.

If, however, the Press and broadcasting are to exercise their role of leadership, they must recognize that their roles are complementary, and must respect each other's functions. Largely, broadcasting, perhaps even television, can be a stimulator, and the Press can satisfy the stimulated appetite. But how effectively that educative function is discharged depends also on whether informed public opinion cares enough to maintain and advance standards, and to see that vigour and openmindedness are brought to the discussion of values and that no shibboleth goes unchallenged; and to speak out to that end, with vision, with care and with courage.

PRINCIPLES OF EXPERIMENTAL PHYSICS

The Physics of Experimental Method

By Dr. H. J. J. Braddick. Pp. xx+404. (London: Chapman and Hall, Ltd., 1954.) 35*s*. net.

THE development of experimental ability rests not only upon example, precept and experience, but also upon the prudent use of books which deal with the methods of experiment. Books of this kind with a wide range and suitable for advanced students are rather few. They tend to concentrate either upon laboratory arts and practice, or upon a course of typical experiments, or upon a range of particular instruments or measurements. Dr. H. J. J. Braddick's book has a different aim. Although he describes various techniques, experiments and instruments, he is concerned to bring out the physical principles by which apparatus may be designed and used to the best advantage in scientific experiments within the general field of physics. As Prof. P. M. S. Blackett remarks in the foreword, physical measurements are now used in most sciences, so that the title "The Physics of Experimental Method" has a topical appropriateness. No single book could fulfil so broad a title, and therefore the author has essentially to make an individual choice of the subjects included. He treats, in fact, the general questions of the

statistical interpretation and mathematical manipulation of experimental results and also the natural limits of measurement set by thermal agitation and other fluctuation phenomena. He describes four fields of measurement and methods, namely, electrical measurements and electronic devices, vacuum techniques, optical and photographic methods and a number of the methods of nuclear physics. In these fields he gives in each section examples of the appropriate instrument technology. He also makes some observations on the construction of apparatus, both design and materials.

The author writes little on the design of experiments, probably because it would have little relevance to the rest of the book. Similarly, he wisely limits the discussion of mechanical features to principles such as kinematic design: mechanical engineering cannot be compressed into a chapter. It was probably also wise to omit subjects adequately treated in standard text-books, such as bridges, potentiometers and many electrical measurements. X-ray analysis and electron diffraction and microscopy need special training outside a general course. On the other hand, interferometry, phase-contrast and polarization would seem to deserve places. Since d.c. amplification and servo-systems are mentioned, the magnetic amplifier should have been appropriately treated. The cathode-ray oscillograph has joined the more traditional tools of general application. Electrostatic instruments and high voltages have now to be used by substantial groups of physicists. The most serious weaknesses are in the chapter on materials, where some data are quoted which are useful to industrialists for limited comparisons of similar materials by artificial tests, but are quite misleading for any other purpose. The author would have done well to restrict himself here to physical principles as he has done elsewhere with such success.

Criticisms of omission are but too easy; they do not mean that anyone else would have made a better choice than Dr. Braddick. In general, he has made the wise selection which is to be expected from his knowledge, ability and experience. He has had to preserve a nice balance between subjects where a physicist will need a special training, subjects where the physicist will usually give instructions to an instrument technologist or laboratory technician, subjects where apparatus can be assembled as delivered from the makers, and subjects where the young physicist, at least, will have to make something himself. If Dr. Braddick has let the balance come down somewhat on the side of his personal interest, this is consistent with the spirit of original work. A book of this kind must be impressed with the character of its author. This character is that of a fine experimentalist and an excellent teacher. Some will think Dr. Braddick has attempted an impossible task; but a student's time is very limited, and he cannot learn everything that everyone would like him to know, so that usually a single book of this type must suffice for detailed study. Nevertheless, in the diversity of university education there is room for various outlooks. We might hope for other books to present outlooks different from that under consideration. Perhaps Dr. Braddick will write one or more of them. There is no doubt that he has made an important contribution to the literature of the subject, that his book should be made available to all advanced students of physics and that other scientists can be confidently recommended to consult it.

S. WHITEHEAD

A LANDMARK IN THE THEORY OF ELASTICITY

Singular Integral Equations

Boundary Problems of Function Theory and their Application to Mathematical Physics. By N. I. Muskhelishvili. (Second edition, Moscow, 1946.) Pp. viii+448. (Groningen: P. Noordhoff, N.V., 1953.) 28.50 florins.

Some Basic Problems of the Mathematical Theory of Elasticity

Fundamental Equations, Plane Theory of Elasticity, Torsion and Bending. By N. I. Muskhelishvili. Translated from the Russian by J. R. M. Radok. (Third, revised and augmented edition, Moscow, 1949.) Pp. xxxi+704. (Groningen: P. Noordhoff, N.V., 1953.) 38 florins.

THE first edition of Muskhelishvili's prize-winning monograph on the mathematical theory of elasticity was published in the U.S.S.R. in 1933. The second edition appeared in 1935, but was soon out of print; a third edition, considerably revised and augmented, was published in 1949. However, the extent of Muskhelishvili's signal contributions to the subject still remained comparatively unknown to Western scientists. The appearance of this translation, excellent in every way, is an event of first-rate importance.

It was in 1909 that G. V. Kolosov first demonstrated that a general plane state of stress in an elastic solid can be expressed, with profit, in terms of two arbitrary analytic functions of a complex variable. Muskhelishvili, first in a joint paper with Kolosov in 1915, and then on his own in a series of some twenty papers at intervals up to 1942, developed this idea in great detail and by its means solved a number of capital new problems and corrected or shortened the treatment of old ones. Kolosov and several other Russians, especially D. I. Sherman since 1934, have also contributed extensively. Similar ideas were formulated independently in 1939 in England by A. C. Stevenson, but the scope of the Russian work has been wider and much more thorough, and has drawn very considerably on complex function theory. In particular, Cauchy integrals play a prominent part, while the general solutions of the two fundamental and the mixed problems of elasticity have been obtained in the form of singular integral equations. Muskhelishvili and others have shown further that these general solutions are not only of academic interest, but also that they yield significant advantages over conventional methods in certain boundary-value problems.

The full account of the basic analysis is to be found in the book on "Singular Integral Equations". Its contents include chapters on the Hilbert and Riemann boundary problems, integral equations with Cauchy-type kernels, the Dirichlet problem, and solution of the generalized Riemann–Hilbert–Poincaré problem. A sufficient discussion of the relevant portions of this analysis appears in the book on elasticity.

The latter's range is indicated by the following selection from the twenty-five chapter headings: solution for regions bounded by a circle; application of conformal mapping; boundary values of holomorphic functions; solution of the fundamental problems for regions mapped on to a circle by rational functions; solution of the fundamental problems for the half-plane; some general methods of solutions of boundary-value problems; the problem of linear

relationship. Complex variable methods are also used in the concluding chapters (amounting to about one-sixth of the whole), which treat the torsion and bending of simple and compound bars of different moduli.

Muskhelishvili's writings cannot fail to make the most vivid impression on every reader by their clarity, their pleasant leisurely style, and their scrupulous attention to detail. There is nothing slipshod in the entire thousand or so pages; every essential point is explained; the exposition is sustained on the highest level even through the appendixes (that on elementary tensor analysis has never been bettered, in the reviewer's opinion). If there is anything to regret, it is that the author's point of view throughout is that of a pure mathematician dealing with a branch of mechanics. The subject is not presented in the round: one aspect only is illuminated. But with what brilliance!

R. Hill

PROBLEMS OF WATER SUPPLY

Vegetation and Watershed Management

An Appraisal of Vegetation Management in Relation to Water Supply, Flood Control, and Soil Erosion. By E. A. Colman. (Sponsored by The Conservation Foundation.) Pp. xv+412+16 plates. (New York: The Ronald Press Company, 1953.) 7 dollars.

ALMOST everywhere in the world there is increasing domestic and industrial use of water, and the rising demand is making more and more difficult the task of the water engineer in supplying an adequate quantity of water of good quality all the year round. Leaving aside the doubtful possibility of significant weather modification by cloud seeding, the engineer's raw material is, at most, that part of natural rain and snow not lost to the atmosphere as evaporation from his catchment areas. This evaporation loss is predominantly a transpiration loss that gives an economic return where it is the working capital of the farmer and forester in the growing of crops, so much so that in many parts of the world it is deliberately increased—by irrigation—as a necessary condition for human survival. Removal of vegetation is not an acceptable solution of the water problem, even if clearance is restricted to that which is valueless as food or timber. The gain in total annual discharge would bring with it increased flood flow, more severe erosion on the catchment area and in the stream channels, more sediment in reservoirs, and still greater shortage of water in dry weather.

The role of vegetation in hydrology is obviously important, and there is complexity in the study of its many aspects: how it influences the evaporation loss, how it affects the retention of rain and snow on the ground, how it affects the penetration of rain and melt-water into the soil and so to underground storage, how it impedes run-off and restricts erosion. Given such basic information and some unifying ideas it should be possible to consider ways of managing the vegetation to exploit the good and minimize the evil effects. Much of the information does exist, and some of the ideas too; but the literature is very scattered, and there is a need for a comprehensive survey of present knowledge and practice. Dr. E. A. Colman, chief of a research division of the United States Forest Services, has attempted such a survey, but it falls a little short of what it could have been.

The book is written for the non-scientist; but this scarcely justifies Dr. Colman in discarding the precision of language he uses in his scientific papers, to substitute a wordiness that leaves little or nothing to the imagination. The result is that interest flags as case after case is treated on its merits, based on the philosophy that results from one catchment cannot be applied to another in a different climate or with a different kind of vegetation. Scientifically this is a philosophy of despair, but even if it is accepted as being all that is possible or desirable at present, the writing still suffers too much from needless repetition within sections. Drastic pruning would have made this a much better book, a book to be read with pleasure and profit.

The subject is so important that many British readers will be ready to take the profit and let the pleasure go, for this account of American experience in management of catchment areas covers a wide range of climates and vegetation types, including all that are found in Britain and many met in the Commonwealth. There are a long bibliography and two indexes—of authors and subjects—the second of which could usefully have been longer by adding more place names. Several of the famous management experiments, such as Wagon Wheel Gap and Coweeta, are best known by their sites; but site names rarely appear in the index of subjects.

The book is well printed, with its subject-matter admirably illustrated in a collection of good photographs and some clear folded maps of the United States. The maps in black-and-white show the distribution of important hydrological elements; another, in colour, shows the distribution of natural vegetation and the types of farming that have been imposed upon it. By modern standards the price is not exorbitantly high, and the book will prove a useful investment for those with an engineering or scientific interest in water, soil, or vegetation.

H. L. Penman

RELAXATION IN PHYSICS AND ENGINEERING

Relaxation Methods

By D. N. de G. Allen. Pp. ix+257. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 53*s*. 6*d*.

An Introduction to Relaxation Methods

By F. S. Shaw. Pp. iv+396. (New York: Dover Publications, Inc., 1953.) 5.50 dollars.

THE method of relaxation has now become an established and important technique in mathematical physics and engineering. The object of the present two volumes is to provide a practical introduction to the technique of relaxation and to illustrate it by reference to the various types of problem which have been successfully solved by this means. As Mr. D. N. de G. Allen so well emphasizes in his book, it is an essential feature of relaxation methods that they are extremely flexible and that they leave the maximum of initiative with the computor. For this reason there can scarcely be a completely systematic account of relaxation, since the whole spirit of the method is to avoid systematization. Both these books give an

account of the various devices which have been successfully employed, such as over-relaxation, block relaxation, group relaxation and the use of multiplying factors; but the great purpose of each book is, of course, to stimulate the student to develop for himself the techniques which are appropriate to the special problems with which he is confronted.

The scope of these books covers linear algebraic equations, linear ordinary differential equations and certain linear partial differential equations, with a special emphasis on the questions of Laplace and Poisson and the biharmonic equation. Another important group of applications of relaxation methods is to eigenvalue problems for algebraic and differential equations. Quite another field of application is to problems where there are free boundaries the form of which is unknown at the beginning of the investigation. Allen's book also gives an account of the use of triangular nets, of the problem of heat conduction and of Southwell's method of intensification in calculating eigenvalues. Shaw's book also deals with the application of relaxation methods to integral equations, the use of Fox's "difference corrections" and gives tables for computing irregular star first and second derivatives near a boundary.

It is very difficult to compare two such similar works; but perhaps it is fair to say that Shaw's book is the more elementary and Allen's is the more philosophical. Certain omissions from Allen's book are quite deliberate, and the author promises another volume in which he will deal with a number of related topics. It would be extremely interesting to have a careful comparison of the method of relaxation with the method of squares as developed by Thom, Morris's escalator method and the hypercircle method of Synge. When a second edition of this book is called for, it would increase its value if some reference were made to the accuracy of the higher eigenvalues obtained by intensification methods and to Tosio Kato's method for estimating the accuracy of eigenvalues in general.

G. TEMPLE

BELIEFS AND SOCIETY

African Worlds

Studies in the Cosmological Ideas and Social Values of African Peoples. Edited by Daryll Forde. Pp. xvii + 244. (Published for the International African Institute.) (London: Oxford University Press, 1954.) 30*s*. net.

BY now a certain amount is known of the social life of non-Western peoples. In the African field we have analyses of political institutions and of kinship, and several general accounts of diverse social systems. This book is an attempt to discuss the beliefs associated with some of them, to analyse the character and the contexts of the value systems of certain African societies. We are given accounts of the cosmological ideas, myths and social values of nine peoples, of varying economic and political organization, from various parts of Africa, and an introduction by the editor.

For several years it has been one of the tenets of social anthropology that there may be a functional interrelationship between the parts of any social system. This hypothesis has been at least tacitly accepted, and research and analysis based upon it have shown its general validity. Research into religious and magical beliefs has demonstrated a close relationship between the system of social relations and that of values, sanctions, codes of conduct and so on, in any one society. An example is that of witchcraft beliefs. What may at first seem a jumble of superstition is integrated closely with, and derives its significance from, the social organization. It is also seen to form a coherent set of beliefs. Once certain premises are accepted—including some denied by Western scientific thought—then the entire structure built upon them is logical and reasonable. Such a system has two aspects, so far as analysis is concerned: its effectiveness in providing values and sanctions for orderly social interaction, and its coherence as a single set of beliefs. But although beliefs in witches may have a similar function in different societies, their form may vary. Similarly with, say, myths of the creation of the world, such as are described in this book. All these peoples have different ideas about the creation and the relationship of men with God and the world. One can regard these ideas as forming closed systems, quite apart from their place in the total scheme of social values. In other words, there is a distinction between the practical and the metaphysical significance of a set of beliefs. The distinction is implicit in every essay in this book.

A system of values, providing a guide to social behaviour, plays an integral part in any society. The types of organization of these various African societies vary, and with them the nature and significance of ties of kinship, territory and so on, from the great kingdoms of Ruanda and Ashanti to the stateless societies of the Lele and the Abaluyia. It can be expected that this variation will be reflected in the social values held by their members. If social anthropology is a comparative discipline, then here is an obvious case for taxonomy as a means towards understanding.

But it is not at all certain that this is so at the level of the myths and cosmologies also described. Since partly, at least, myths explain the place of men in the world, then the form of the society may be reflected to some extent in their content. Those of the Shilluk kingship provide an admirable example, as giving a means for the comprehension by the Shilluk, through the use of symbols, of the nature of the Shilluk polity. But there is much in Shilluk myth that seems to have no function, in this sense, at all. This is even more true of the cosmologies described, notably the elaborate system of the Dogon. Even here there is consistency, or at least a lack of contradiction. But this interrelationship is of a very different order from that between the form of social relations of a society and the code of behaviour prescribed by certain of its social values.

In short, this book tries to consider two problems, which are not clearly distinguished: the relationship between society and those of its values which guide social action, and that between society and its myths and cosmological ideas. There is clearly a functional relationship in the first case, but the nature of the relation in the latter is open to doubt. The myths may validate the existing status systems of persons and groups, but the cosmologies seem to defy attempts to analyse them as anything but closed systems of thought. We are given nine excellent and fascinating essays; but these do not, as one feels that perhaps they might have done, combine to make a book which advances our sociological understanding of religious belief. The fact that they do not do so raises the underlying problem of the ultimate limits of sociological analysis.

JOHN MIDDLETON

ACOUSTICS OF THE SINGING VOICE

At the Friday Evening Discourse given in the Royal Institution, London, on June 18, Mr. G. Mackworth-Young spoke on "What Happens in Singing". Much argument has been devoted to the question of whether singing is an art or a science. To the extent that the singer needs as his prime requisites a nice appreciation of pitch and good muscular control, it is primarily an art; yet in the process of learning to sing it is helpful to know something of the physics and physiology of the voice, though, of course, one does not while singing continually and consciously set the vocal apparatus into positions which theory would indicate as desirable. It is rather like riding a bicycle; at the beginning it is necessary to know something of the technique of propelling and balancing the machine, but in time this becomes automatic and to think consciously of each movement soon results in falling off.

The human vocal apparatus consists of the chest (bellows), larynx containing the vocal cords (source of vibration) and the throat, mouth and nasal cavities (resonators). The production of tone has often been likened to that in a reed pipe of the wood-wind class, but perhaps a brass instrument of the trombone type gives a closer analogy, since both the size of the resonators and the tension and length of the vibrating tissues are adjustable. The true or lower vocal cords are set in vibration by approximating their edges under the tension necessary to produce a note of the required frequency, and the breath is expelled through the narrow slit between them. This process sets the edges in vibration either as a whole (normal register) or in part (falsetto register), and these vibrations may be seen with a combination of the laryngoscope and stroboscope. The mathematical theory of this vibrating system has been given by Wegel. Experiments on excised larynxes have shown that, as would be expected, the quality of the unaided vocal cords is raucous and unmusical. It is mainly by the modulating influence of the resonating cavities upon the laryngeal tone that man is able to transcend the lower animals in speech and song, though the parrot and certain members of the ape family possess this faculty to a limited extent.

We turn to the important modifications produced on this still rather unmelodious 'buzzer' note by the resonance column, which it now has to pass through. The natural vibrations of the latter in the absence of a buzzer note may be heard in whispered speech or in whistling, when the vocal bands are drawn aside and a stream of air passes through practically uninterrupted at the larynx. Phoneticians usually distinguish three principal resonances: the back cavity (throat), the front cavity (of the mouth) and the nasal cavity. The acoustic impedance of the latter is then a 'shunt' upon the front part of the mouth. Further, the nasal cavity may be completely cut out, in the production of certain sounds, by the large impedance of the constriction where it joins the throat. In the absence of damping, each cavity may be regarded as an acoustic capacitance and each constriction as an inertance.

Of course, the division into capacitances and inertances must not be regarded as too rigorous. In some vowels the whole resonance system approximates to a wide open funnel stretching from larynx to lips. Actually, the damping is very large, much more so than in a wind instrument, owing to the resilient nature of the walls of the cavities. This has the practical effect of broadening all the resonances. It makes it rather difficult, in fact, to test the natural resonances of the system held in a given position by such methods as bringing tuning forks in front of the mouth. Again, although tables of resonances for various vowels are given, there are small discrepancies between the resonances detected by different investigators, and those not entirely due to phonetic uncertainties—for example, in the pronunciation of the vowels or the pitch of the cord note. Damping tends, in fact, to confound together the theories of Helmholtz and Hermann on the subject of the wave forms of vowels.

While it is true that we find, with the latter, that as one sings a vowel up the scale each cord-note has the 'formant' of the fixed resonance cavities impressed upon it, these resonances are so broad that the probability will be that a number of the harmonics of the cord-note will elicit some resonance in the mouth cavities, giving apparent agreement with the Helmholtz relative pitch theory of vowel overtones. This has the result that, within limits, the wave-form of a vowel is preserved as the cord-note is changed. This would not be so in a brass instrument where rigid walls and consequent sharp resonances impress a very pronounced formant on each note, altering the wave form as the player moves up the scale.

One difference between artificial wind instruments and the voice is in the type of resonance employed. In nearly all wind instruments standing waves are set up in the resonance tube, and the pitch of the note is therefore decided by the tube length. The voice, on the other hand, employs resonators of the Helmholtz type in which the inertance of the mouth and nose orifices is in series with the capacitance of the oral cavities. The resonance frequency therefore depends not only on the size of the cavities but also on the size and shape of the opening. The throat and mouth cavities are chambers of easily variable shape having soft elastic walls. They form resonators of low 'Q' in comparison to the resonator of a wind instrument, and so are readily tuned to a range of pitch. They accept a note from the vocal cords and give it body and quality by tuning their resonances to coincide with either the fundamental cord frequency or with certain harmonics. The auxiliary head resonators, being of fixed size and shape, contribute higher harmonics by forced vibration.

The fact that the bass voice can produce notes of wave-length 11–14 ft. indicates that here the voice resonance must all take place on the higher harmonics. Although the greater part of the sound energy is distributed among these harmonic resonances, we normally associate the pitch with the fundamental. This is due to the ear, which has the gift of extracting the fundamental, even if weak, from such harmonics as are presented to it.

Before dealing with the resonance compass of the various voices, it is necessary to consider briefly the question of vowel production. The combination of two resonances at a particular frequency produces an additional quality in the voice which no other

instrument possesses and which the ear perceives as a vowel. Different vowels are produced by modulating the resonance of the cavities in much the same way as when reinforcing a vocal cord note. However, the vowel resonances ('formants') need not bear harmonic relation to each other. It follows that, in singing, the cavities are required to produce resonances which must be harmonics of the vocal note and at the same time fall within the formants of the vowel. These two requirements may conflict, and the claims of the note must then take precedence. This is the case in the upper range of the soprano voice where vowel production becomes a matter of great difficulty. The lower voices, being richer in harmonics within the resonant compass, are less troubled by this effect.

Much research has been carried out to determine the range of resonance in the throat and mouth cavities employed in the various voices, and recently this work has been greatly facilitated by the introduction of new electro-acoustic techniques. The normal range of resonance of the throat cavity for the male voice extends from $A_1\flat$ to $E_2\flat$ in the treble clef. Bass and baritone notes from the lowest up to $E_1\flat$ (on the bottom line of the treble clef) are reinforced on whatever harmonics lie within this compass. Notes lying between $E_1\flat$ and G_1 are resonated on the fundamental by a forced enlargement of the throat cavity. In women the normal compass of resonance stands squarely in the middle of the soprano voice extending upwards from the G_1 in the treble clef to the $F_2\sharp$ above. The notes within this range will naturally be reinforced on the fundamental, while lower tones find resonance on the first or second harmonic. When the voice rises above $F_2\sharp$ the throat resonance must be raised above its normal range, and this is achieved in trained voices by an enlargement of the throat cavity aperture.

Mr. Mackworth-Young has himself demonstrated the existence of two resonant zones in the throat having a compass of four semi-tones each in the men's voices (four and eight semi-tones in women's voices). It was found that if the vocal note happened to have harmonics in both zones, then both harmonics were heard. Notes which have two harmonics within the same zone may be resonated on either one but not both. The exact significance of this discovery awaits interpretation.

The normal compass of resonance for each voice shows a remarkable uniformity among singers of differing ages and nationality, individual variations rarely amounting to more than a semi-tone in either direction. The vowel, demanding as it does absolute pitch of resonance, is even more exacting in its requirements. This uniformity is achieved because the note of a Helmholtz resonator varies according to its size in relation to its opening; and as the mouth and throat capacities of the two sexes and various ages differ, so the mouth openings differ with them, thus maintaining the same proportions.

The throat cavity resonance on any particular note appears to be independent of the vowel which is being sung. It would appear, therefore, that throat resonance plays little or no part in vowel production, but the matter is still open to question. The nature of the vowel sounds has been under investigation since the beginning of the nineteenth century, and the pitches of the formants involved in the production of each vowel are now well established. For some vowels the lower formant does lie within the compass of throat resonance, while the upper formant is undoubtedly supplied by mouth resonance. For other vowels (for example, *ai* and *ee*) the mouth is divided by the tongue into two cavities which appear to provide the two formants independently of the throat resonance.

Much remains to be done to elucidate the acoustical processes in full of orchestral wind instruments; so it is with the voice. A good singer may be readily distinguishable from an indifferent one merely by listening to him; but if the indifferent singer is to be helped to improve, the scientific principles underlying the good singer's skill must be studied. In particular, studies should be made of 'attack' and 'vibrato' as practised by trained singers.

THE INTERNATIONAL BOTANICAL CONGRESS IN PARIS

IN 1854 the Société Botanique de France was founded, and it was very fitting that the centenary of this event should coincide with the meeting of the Eighth International Botanical Congress in Paris during July 2–14. The Congress was very well attended; the incomplete list of members and those accompanying members contains more than two thousand names, derived from about seventy different countries. Thus this Congress was even more truly international than that held in Stockholm in 1950.

The work of the Congress was divided between twenty-seven sections: International Union of Botanical Sciences; Nomenclature; Terminology; Taxonomy; Palæobotany; Palynology; Phytogeography; Morphology and Anatomy; Cytology; Genetics; Plant Physiology; Agronomy; Forestry; Standardization of Raw Materials of Plant Origin; Ethnobotany; Bryology; Phycology; Lichenology; Mycology; Plant Pathology; Bacteriology; Protection of Materials and Equipment; Soil and Water Microbiology; Nature Conservation; History of Botany; Botanic Gardens; Mediterranean Botany.

The above list may seem to disperse the subject over a very wide field, but it should also be noted that many sections were still further divided; for example, there were three sub-sections of Physiology, namely, Nutrition, Growth, Physiological Ecology. On a day chosen at random there were thirty-five different papers being read simultaneously; thus the subject had been so dissected that there were very few papers of general interest, and those attending the Congress had to be very ruthless in their decisions which section to attend, otherwise much valuable time was lost trying to keep track of two fields of interest housed in widely separate parts of the Sorbonne. One wonders if this process of sub-division has gone too far and there really is no longer a science called 'botany' but only some twenty or thirty separate sciences. One factor, however, eased this situation. The nine volumes comprising the Congress papers were available at the beginning and enabled one to decide which communications were most appropriate to one's own interest.

Most sections, while allowing time for miscellaneous communications, concentrated on a few main topics on which colloquia were held. These colloquia took the form of a *rapport* which usually summarized the position and lasted for an hour, followed by

discussion for thirty minutes. Then came a series of brief communications by workers in the field under discussion. Thus one was given a fairly comprehensive background plus an indication of the growing points of the topic, and the discussion of the points raised was also very valuable. There were also many joint colloquia; for example, a discussion of "Quaternary Climate" organized by the Palynology Section was attended by the Phytogeography Section, while one on "Fungal Growth" embraced mycologists and physiologists.

The programme on the whole was well organized, although a lax attitude to time-keeping often meant that valuable communications were crowded out or had to be presented in a form so abbreviated as to be incomprehensible and almost valueless. There was also a certain confusion in some sections where papers were allocated 'time-units'. At an international congress, the symposium is the best form of meeting; but the clarity of the paper should not be sacrificed to length.

There was much variety between the sections in the use of language. The Congress programme laid it down that French and English were the preferred languages, but the writer also heard papers in German. One agrees that German should be allowed at such meetings; but in the discussions the use of an interpreter was urgently needed on several occasions, a question being asked in one language, answered in another, while part of the audience was more at home in a third. Translation, of course, uses valuable time but it is worth it, for those who do not understand may be those who might contribute most to the discussion.

It is impossible to give an adequate idea of the topics dealt with during the Congress, but there should be some indication of the subjects studied. Among others, the following were very valuable and interesting symposia: secondary and tertiary floras (palæobotany); ecology of cold areas (phytogeography and ecology); experimental embryology (morphology); extra-nuclear inheritance (genetics); photosynthesis (physiology); photoperiodicity (physiology); morphological and physiological gradients (morphology and anatomy); forest pathology (forestry); ecology of marine algae (phycology); bryogeography (bryology); taxonomy of lichens (lichenology); fungal pigments (mycology); virus diseases (plant pathology); etc.

The social side of the Congress was well organized. The opening plenary meeting was held on July 2 in the Grand Amphitheatre of the Sorbonne under the presidency of the Rector of the University of Paris. Short addresses were given by Profs. Schopfer (Berne), Thimann (Harvard–Cambridge) and Heim (Paris). On the evening of Saturday, July 3, the Muséum National d'Histoire Naturelle gave a reception to all members of the Congress in the Zoo at Vincennes. Sunday was free to take advantage of the facilities offered by the Congress to visit the gardens and greenhouses of the Museum and the Arboretum Vilmorinianum in Verrières-le-Buisson. On Wednesday, July 7, at 5 p.m., the Congress met with the Société Botanique de France, and official delegates presented addresses and good wishes on behalf of their parent societies. M. Roger de Vilmorin delivered a short address and showed many beautiful coloured slides of the vegetation of France.

On Tuesday there was a general excursion to Versailles. The final general excursion was held on July 9, when many members enjoyed a day trip to Fontainebleu. The many members who attended had a relatively fine day which made botanizing in the Forest a pleasure.

There were sundry receptions for official delegates by various bodies; but the Congress concluded its official business at a plenary session on Monday, July 13. Here addresses of thanks and good wishes were delivered and the Congress closed with the decision that the Ninth International Botanical Congress should be held in Canada in 1958.

There were many excursions, some fairly local, some going as far afield as North Africa. In addition, the Section Mediterranean Botany held an extension of the Congress in Nice, where in addition to communications there were many excursions along the coast and into the mountainous hinterland.

In such a brief account of the proceedings of the Congress it is inevitable that emphasis is laid on those aspects of the proceedings which deserve re-examination. But criticism of details should not in any way detract from the general excellence of the work of the organizing committee. The Congress viewed *in toto* ran smoothly and well, and it is to be hoped that subsequent Congresses will follow the admirable precedents set by those at Stockholm and Paris.

A. R. Gemmell

LOCALIZATION IN THE CEREBRAL CORTEX

A SYMPOSIUM on localization of function in the cerebral cortex was held in Oxford on September 8. Arranged by Section I (Physiology) of the British Association jointly with the Physiological Society, this symposium brought together workers from a number of disciplines converging on neurology and a large audience evidently drawn from many sections of the Association. Although the problem of cerebral localization is nowadays too complex to provide a clear-cut issue, there can be no doubt that it represents a convenient theme around which to group a variety of contemporary inquiries in the neurological field. The organizers of the symposium are to be congratulated on their choice of a topic which is not only of central importance in neurology but which also can be relied upon to attract widespread interest among biologists.

Intelligence and Brain-Size

The symposium was introduced—most appropriately—by Dr. E. D. Adrian, president this year of the British Association, who raised two important, if closely related, issues. First, the question of brain size in relation to the type of activity commonly called intelligent; and secondly, the mode of specialization of function within the cortex. As regards the first issue, Dr. Adrian pointed out that absolute size of brain no less than its general arrangement would appear an important factor in the evolution of the mammalian nervous system. He suggested that this might be explained either by supposing that an increase in brain-size permits greater subdivision—and hence localization—of function, or by assuming that intelligent activity depends upon a large amount of unspecialized cortical tissue. Both answers, in Dr. Adrian's view, are right up to a point, and the real question we have to ask is how much of the brain is allotted to special activities and "what happens to the rest".

Dr. Adrian then gave a summary review of the history of cerebral localization of function, ranging from Gall, through Broca, Fritsch and Hitzig, and Ferrier, to the more guarded concepts of localization characteristic of present-day neurology. While steering a careful course between the Scylla of extreme localization and the Charybdis of cerebral mass-action, Dr. Adrian left no doubt that the integration of behaviour to meet the needs of the environment presupposes, in his view, some measure of localization of its component functions. Only in the case of the sensory projection areas of the cortex, however, can we regard the evidence for functional segregation as really complete; and even here, Dr. Adrian was careful to point out, we cannot speak of the translation of sensory signals to sensation as being 'localized' in these areas—or indeed anywhere else. In the same way, he warned against the dangers of undue rigidity in arguing from the results of cortical stimulation experiments to the localization of motor function. In the control of behaviour, he suggested, total mass of cerebral tissue may be just as important as the finer details of structure. None the less, Dr. Adrian appeared to envisage some degree of cortical specialization, motor no less than sensory, the final integrative activity of the brain being unified in some way not as yet understood. "We are still entangled in the Departments," he concluded; "it may be long before we get through to H.Q."

The Excitable Motor Cortex

The problem of cerebral motor function was taken up in greater detail by Prof. E. G. T. Liddell (Oxford), who gave a masterly survey of experiments on the motor cortex, using the method of direct electrical stimulation. In discussing the earlier work, particularly that of Ferrier, he suggested that the punctate localization of discrete movements which it appeared to indicate was due at least as much to meticulous draughtsmanship as to the realities of cerebral organization. None the less, given the many and often ill-controlled variables in these experiments, the consistency of the results was not a little surprising. Turning to more recent work, Prof. Liddell directed attention to the great importance of proper control of the parameters of stimulation. He pointed out that the use of single strong stimuli in the anæsthetized brain, or of repetitive stimuli in the unanæsthetized human brain, leads to an appreciable increase in the size of the cortical area from which discrete movements of a given part of the body may be elicited. Had the earlier investigators used single instead of repetitive stimuli, he contended, they would have obtained a 'motor map' corresponding far more closely with that inferred by Hughlings Jackson from the sequence of events in epileptic seizures. He considered that the modern 'motor map', constructed on the basis of the responses given to single stimuli of varying intensity, provides an important clue to the functional organization of the motor cortex in man.

Prof. Liddell made it clear that the movements evoked by cortical stimulation can in no sense be equated with the 'voluntary' movements of the intact organism. Their time relations, in particular, are very different. Movements evoked by cortical stimulation show long latency and gradual build-up. Voluntary movements, on the other hand, are considerably more rapid. Evoked movements, moreover, are not unlike those obtained when the crossed extensor reflex of the cord is elicited by stimulation of a mixed nerve. This similarity, in Prof. Liddell's view, may be due to the fact that in both cases inhibitory no less than excitatory effects are involved. In support of this contention, he adduced the fact that weak single stimuli applied to the cortex evoke a 'flick' response of very brief duration.

Although these relationships stand in need of further elucidation, Prof. Liddell was able to offer a tentative hypothesis of cerebral motor organization. Integrated action, he suggested, presupposes inhibition no less than excitation. In voluntary movement, large groups of skeletal muscles must adopt a static postural attitude as background to the specific movement demanded. It is therefore likely that the central activity issuing in a particular movement, no matter how small, involves a large area, if not the whole, of the motor cortex. In this connexion, Prof. Liddell directed attention to the smaller cells in the motor cortex, which may well play an important part in integration, particularly in its inhibitory aspects. Although this hypothesis necessarily lacks precision, Prof. Liddell indicated its broad agreement with what is known regarding the organization of subcortical neural mechanisms, for example, the respiratory centre in the medulla, and with certain evidence from clinical neurology regarding the organization of the human motor cortex.

A Radical View of Cortical Motor Function

Dr. J. A. V. Bates (Neurological Research Unit, National Hospital, Queen Square, London, W.C.1) took issue with the traditional conception of the motor cortex as the 'repository of willed movements'. In Dr. Bates's view, the only inference that can be drawn from the results of experiments on cortical stimulation is that anatomical connexions exist between particular points in the cortex and particular groups of voluntary muscles. In this connexion, he referred to Burdon-Sanderson's demonstration (which he himself had confirmed) that precisely the same results are obtained by stimulation of the white fibres of the cortico-spinal pathway as by stimulation of the grey matter itself. Dr. Bates further stressed the infantile and athetoid character of the movements evoked by stimulation and their obvious similarity to epileptic phenomena. In his view, the only special qualities associated with cortical evocation are in relation to latency, facilitation and after-discharge. In short, the findings of cortical stimulation reveal no more than the facts of motor organization at the spinal level.

As further evidence in support of his thesis, Dr. Bates adduced the frequent contradiction between the results of experiments on stimulation and ablation of the motor cortex. In certain cases of long-standing unilateral brain disease, for example, he has found that a complete 'motor map' may be obtained from stimulation of the affected hemisphere. None the less, its removal is not followed by loss of the movements produced by stimulation. Despite the classical evidence of hemiplegia, therefore, it is becoming increasingly difficult to regard the motor cortex as in any sense the 'organ' of volitional movement.

In view of these, and many related, considerations, Dr. Bates has been led to propose the radical view that the whole conception of the cortical representation of movement, as evolved by Hughlings

Jackson and traditionally accepted in neurology, be abandoned. The only truly motor centres, he suggested, are in the spinal cord. "It may be that stimulation of the cortex in general does not demonstrate that fibres are efferent from a functioning motor centre, but rather that in the region of the electrode there is the origin of one of the many sets of afferents arising from perhaps a dozen or more different regions on both sides of the hind, middle and fore brains to impinge on each spinal centre." On this view, therefore, the cortico-spinal pathway is to be regarded as afferent rather than efferent in function, and the motor cortex itself as possessing no special role in the representation of voluntary movement.

It is plain that Dr. Bates's position implies a radical break with the traditional doctrine of the hierarchical organization of function in the central nervous system. Although his view is perhaps unduly extreme, it is unlikely that Dr. Bates meant to suggest that the cortex plays no part whatever in the initiation of voluntary movement—indeed, mere comparison of a decorticate preparation with an intact animal is sufficient to establish the contrary. What he doubtless meant to stress is that the motor cortex cannot be regarded as a 'centre for movement', that is, as an essential organ possessing its own intrinsic functions. Support for this view comes from many sources, not least the experiments of Lashley on the effects of ablation of the motor cortex upon acquired skills in rats and monkeys. None the less, it is unlikely that many neurologists will see fit wholly to endorse Dr. Bates's opinion at the present time. The more cautious view of Prof. Liddell, which ascribes some part at least of the integrative activity issuing in movement to the excitable motor cortex, is likely to secure a wider measure of acceptance.

Ablation Studies in Monkeys

The effects of ablation of small areas of the motor cortex in monkeys were described by Dr. F. P. Glees (Oxford), who directed particular attention to the summative influence of multiple small lesions in a given area. In the case of the 'arm area', for example, small lesions which individually occasion little or no disability 'sum up' in regard to their effects upon arm function. Dr. Glees further laid emphasis on functional factors in the establishment of connexions between the motor cortex and the effector organs of the body.

A short film illustrating tests of manipulative skill suitable for use with monkeys in ablation experiments was presented by Mr. J. Cole (Oxford).

Speech and Handedness

Prof. O. L. Zangwill (Cambridge) was concerned with the general relationship between handedness, cerebral dominance and aphasia. He directed attention to the frequency of aphasia associated with lesions of the left cerebral hemisphere in left-handed patients, and suggested that a dissociation between handedness and cerebral dominance is far from unusual. In explanation, Prof. Zangwill pointed to the fact that neither hand preference nor cerebral dominance is fully established at birth. In view of what is known regarding the growth of hand preferences in children, it is entirely possible that many left-handers owe their left-handedness not to heredity but to some more or less contingent circumstance of early development. In such cases, he argued, it would appear that language none the less becomes organized in the left hemisphere, as in the congenitally right-handed individual. At the same time, Prof. Zangwill was careful to indicate the complexity of the relationship between innate and acquired factors in cerebral dominance and the need for their further elucidation.

Cortical Factors in Nystagmus

Dr. E. A. Carmichael, Dr. R. M. Dix and Dr. C. S. Hallpike (National Hospital, Queen Square, London, W.C.1) reported on the effects of localized cerebral lesions upon optokinetic and caloric nystagmus. Dr. Hallpike, who read this paper, pointed out that a characteristic disturbance of optokinetic nystagmus, presented as directional preponderance towards the side of the lesion, occurs only when the latter involves the posterior parietal region of the cortex. A comparable disturbance of caloric nystagmus, on the other hand, occurs only in cases in which the posterior temporal region is involved. Although both types of nystagmus are known to depend on subcortical reflex mechanisms, Dr. Hallpike pointed out that the cortex must obviously exert a modifying influence. Its precise nature, unfortunately, is not at present understood. None the less, these findings have evident value in providing additional 'localizing signs' of circumscribed cerebral disease.

O. L. Zangwill

HORMONES AND CONTROL OF ZOOLOGICAL FUNCTION

A MEETING of Section D (Zoology) of the British Association was held in Oxford on September 7, with Prof. J. E. Smith in the chair, to discuss "Hormones and Control of Zoological Function". It was opened by Mr. D. B. Carlisle with a review of recent advances in our knowledge of the hormonal control of moulting in the Crustacea. The discovery during the past few years of the true nature of the X-organ – sinus gland complex of the eye-stalk has proved a stimulus to research in this field, and it is now established that the accelerating effect upon moulting of removal of the eye-stalk in crabs and crayfish is a result of the production in the neurosecretory cells of the X-organ of a hormone which is stored in the sinus gland and which restrains the onset of the moult. Carlisle brought forward evidence that the contradictory results sometimes reported may be due to the existence in most higher Crustacea (except crabs and crayfish) of a second (distal) part of the X-organ which resembles the sinus gland in consisting partly of enlarged nerve endings. In such forms the neurosecretory complex of the eye-stalk produces a second hormone which accelerates the processes of the premoult, probably acting primarily upon the separation of the old shell; and the effect of the removal of the eye-stalk will then depend upon the balance normally existing between the two hormones. This, he suggested, could account for the fact that in some species the operation had been found to result in either acceleration or retardation of the moult according to the particular population under investigation.

Moulting itself cannot be regarded as an isolated act, for it is preceded and followed by periods in which the metabolism and behaviour of the animal are greatly modified, while growth, in the sense of increase in organic matter, takes place during the intermoult phase when the metabolism and behaviour have returned to 'normal'. Since the moulting hormones influence the duration of this latter phase, they must be regarded also as growth hormones, and it is to be expected, therefore, that further complications of endocrine control remain to be revealed in this field; it is thus significant that Gabe has recently postulated a third hormone, in the absence of which the act of moulting cannot take place even though the premoult may have proceeded normally.

Elasmobranch Endocrine Organs

Research in vertebrate endocrinology has been concentrated so largely upon the Mammalia that there exist at the present time startling gaps in our knowledge of the lower forms, a situation well brought out by Mr. C. K. Goddard's review of the physiological status of elasmobranch endocrine organs, in which he referred also to work in progress at the Gatty Marine Laboratory. The pituitary appears to be the 'master gland' in this group, as in others; but the evidence for the existence of some of its expected hormones is very incomplete, and there is need for much more information as to the source of these hormones within the gland. So far, only the chromatophore-expanding and diabetogenic hormones have been localized, the former in the neuro-intermediate and the latter in the anterior lobe. Thyrotrophic hormone is thought to be present, but the evidence for its existence is meagre in the extreme; indeed, evidence that the thyroid shows little or no sign of involution at nine to ten weeks after hypophysectomy, and that goitrogens are ineffective, as judged by histological criteria, at dosage-levels that will elicit a response in teleosts and mammals, would seem to cast some doubt on the importance of this hormone in elasmobranch physiology.

Gonadotrophins are thought to be present in elasmobranchs, for hypophysectomy results in a slow involution of the gonads; it has also been claimed that the pituitary is necessary for ovulation in the viviparous *Mustelus canis*, but this appears not to be the case in the oviparous *Scylliorhinus canicula*. Possible endocrine functions of the gonads are suggested by observations that testosterone will increase the length of the claspers in young males and that œstrogens cause growth of the reproductive tract in young females; but this is a field in which direct evidence is greatly needed. Work so far done on the inter-renals has provided evidence that they are essential to the life of the skate, and that extracts prepared from them will maintain life and growth in adrenal-ectomized rats, while mammalian cortical extract has been found to prolong the life of inter-renal-ectomized *Torpedo*. Such observations support the view that the elasmobranch inter-renals are the homologue of the mammalian adrenal cortex; but the fact that they seem to play no part in electrolyte metabolism suggests at least one important difference in function. It seems clear that the comparatively few pioneer workers in elasmobranch endocrinology have inevitably been much influenced by preconceptions drawn from mammalian physiology. The results so far obtained certainly suggest some similarity of pattern between the lower and higher vertebrates, but the evidence at present is so fragmentary that it would seem prudent at this stage not to anticipate too close a correspondence, but rather to be vigilant for the significant points of difference.

Use of the South African Clawed Toad

One of the obstacles to the study of elasmobranchs is the obvious difficulty of maintaining them satisfactorily in the laboratory, and a refreshing contrast to this is evidently provided by the South African clawed toad, *Xenopus laevis*, which was dealt with in the next two papers, and which was shown in them to be an admirable subject for endocrinological research and assay. This animal, which can be induced to reproduce at any time of the year, and which differs from British amphibians in lacking the complication of a terrestrial phase in its life-cycle, has proved of value in pregnancy diagnosis; analysis of the influence upon it of gonadotrophins is thus of considerable practical importance, and was the subject of Mr. B. M. Hobson's review. The effect of the pituitary in maintaining the activity of the gonads is clearly shown by the results of hypophysectomy, which leads in six months to a 70 per cent reduction in the weight of the ovaries and a 66 per cent reduction in that of the testes, while marked regression of the oviducts also occurs, to the extent of a 50 per cent loss in their weight within three months. A further result can be observed in males, for in these, when they are in breeding condition, there develop so-called 'gloves', consisting of closely-set pigmented spines which appear in three clearly-defined stages, first on the skin covering the digits and metacarpals, then over the radio-ulna and lastly over the humerus as far as the axilla. Hypophysectomy of the 'fully-gloved' male results in complete loss of the 'gloves' in five to fifteen days after the operation, although they can be maintained in existence by the injection at frequent intervals of suitable doses of gonadotrophins. That the pituitary exerts this effect through the gonads, possibly by stimulating the production of an androgenic hormone, is shown by the fact that castration also results in the loss of the 'gloves', and that these cannot, in the absence of the gonads, be maintained by gonadotrophin injections.

Gonadotrophins from various sources (for example, anterior lobe of the pituitary, or pregnancy urine) will, if given in sufficiently large doses, affect both sexes of *Xenopus* and bring about the release of ripe sperm and ova, the male being more sensitive in its response than the female. In this way a supply of tadpoles can be obtained throughout the year, and Dr. J. M. Dodd, in his account of recent work on their metamorphosis, described the extensive observations which he has made in order to establish satisfactory techniques for the use of this very convenient material for purposes of assay. The effects of food and temperature on growth and metamorphosis of the larvæ were considered in some detail, and it was shown that foods of vegetable origin are virtually inactive in producing growth, provided that the water is changed regularly so that decomposition products are removed and micro-organisms not allowed to develop. The ciliary feeding habits of the larva make it convenient to use liver powders as food, but it appears that these may contain widely varying amounts of a 'metamorphic principle' (presumably organic iodine), so that meta-

morphosis under fully controlled experimental conditions may be induced in some cases in as little as ten days, whereas in other cases no metamorphic signs are visible even after 260 days. The effect of temperature on growth and metamorphosis was also considered, and it was shown that, contrary to previously accepted practice, large metamorphically-retarded larvæ suitable for assay work can best be reared at a temperature of 15° C.

The practical value of such studies was shown when Dodd described his procedures for assaying by immersion and injection, and explained the use which can be made of thyroidectomized tadpoles, for he has been able to compare the metamorphic potency of L-tri-iodothyronine and L-thyroxine, to assay thyroid powders from lower vertebrates, to examine the iodine content of blood serum from patients suffering from various disorders of the thyroid, and to assay minute quantities of thyrotrophic hormone.

In conclusion, he referred to the discovery in the neighbourhood of St. Andrews of a population of the newt, *Triturus helveticus*, in which five specimens were found to be neotenous and to show extensive enlargement of the thyroid glands. He suggested that these goitres might well be due to the action of goitrogens from yellow turnips growing in the vicinity, and expressed the hope that others might look for similar populations elsewhere, since this condition is unique in the literature and has not so far recurred in the St. Andrews population.

The Thyroid in Vertebrate Evolution

In the last paper of the session, Prof. E. J. W. Barrington discussed the thyroid gland in relation to vertebrate evolution, with particular reference to some problems of teleost endocrinology which are under investigation at Nottingham. Goitres have long been known to arise in trout which lack an adequate supply of iodine, and it is now well established that chemical goitrogens will cause hyperplasia and hypertrophy of the thyroid in teleosts similar to the effects produced by them in mammals. There is much evidence that the production of thyrotrophic hormone by the teleost pituitary is the agent in this response, and Barrington and Matty have been able to identify the cells which actually produce this hormone in the minnow. They are found to be cyanophils, positive to the McManus – Hotchkiss periodic acid – Schiff (PAS) reaction, which are coloured by the aldehyde-fuchsin stain of Gomori and Halmi, and the situation bears a striking resemblance in detail to that already known to exist in the mammalian pituitary.

These results, taken in conjunction with the work of Atz in the United States, indicate that already in teleosts the pituitary – thyroid relationship is established in an essentially mammalian form, and this suggests that from an early stage in vertebrate evolution the thyroid may have had an important part to play in adaptation to the external environment and to its seasonal changes. In considering the nature of this role, there is little positive evidence for an involvement of the thyroid in the stimulation of metabolism in fish. Although there are several reports of gonadal regression resulting from the immobilization of the thyroid by thiourea, it is not clear that this effect is actually mediated through that gland, for it has been found that minnows can complete spermatogenesis during winter, under the stimulus of artificial light, when the thyroid is immobilized by a different goitrogen, thiouracil. However, evidence is accumulating from various sources that fluctuation of thyroid action occurs in correlation with the phases of migration and spawning in certain teleosts, and the future may well show that it is the function of this gland to provide support at these periods of physiological stress or, as Hoar has argued, to activate the nervous centres which set off the characteristic appetitive behaviour associated with them.

Little time was available for discussion; but the papers alone made it clear that the field of comparative endocrinology, now attracting a welcome and rapidly increasing attention, offers scope for extensive cultivation. It is evident, too, that a satisfactory grasp of the principles of functioning of endocrine systems demands careful investigation of the problem of how far these systems have been subjected to functional changes in response to the changing stresses which the major groups of animals have encountered in extending their conquest of their environment. E. J. W. Barrington

OBITUARIES

Dame Janet M. Campbell, D.B.E.

The gratifying reduction of maternal mortality which has occurred in the past decade is largely due to the scientific discoveries of the sulphonamide drugs and the antibiotics which inhibit the organisms responsible for puerperal sepsis. Again, in the reduction of infant mortality these preparations are of service; and the advances made in biochemistry, especially in the discovery of vitamins, enable children to be brought up on sound principles of nutrition, as demonstrated by the special arrangements made for the diet of mothers and children during the Second World War.

Equally, however, merit must be assigned to the administrative pioneers in maternity and child welfare, who made it possible for these triumphs of research and knowledge of the best methods for the care of mothers and the nurture of children to be applied in British homes. Among these pioneers, Dame Janet Campbell, whose death occurred in London on September 27, takes high place.

Janet Mary Campbell was born in 1877, daughter of George Campbell, of Barnham, Sussex. She studied at the London School of Medicine for Women, graduating M.B., B.S. in 1901, proceeding to M.D. in 1904, and to M.S. in 1905 in the University of London. After holding hospital appointments, she became an assistant school medical inspector under the London County Council in 1905. In 1908 she was appointed a medical inspector of the Board of Education. Much voluntary work by suitable infant nurture and feeding had been done first in France and afterwards in Great Britain to combat the high rates of infantile mortality; but the rates were still high in industrial towns. It was time for the State to take legislative action. The Board of Education in 1907 was empowered to give grants-in-aid for educational work in infant welfare and later for 'Schools for Mothers'. Sir George Newman, the chief medical officer of the Board, assigned the medical direction of this work to Dr. Janet Campbell. She made valuable suggestions which were incorporated

in official memoranda, and undertook extensive tours throughout England and Wales to impress the need for infant welfare on local educational authorities. At this time also Sir Arthur Newsholme's important reports influenced the Local Government Board to stimulate local authorities by State grants to provide a maternity and child-welfare service. The establishment of the Ministry of Health in 1919 with Dr. Campbell as the senior medical officer of the Maternity and Child Welfare Branch and similar rank in the Board of Education integrated medical administrative work in Whitehall on this subject.

At the Ministry of Health, Dame Janet and her able staff did excellent work. In addition to serving on a number of important Government committees, including the War Cabinet Committee on Women in Industry, the Committee on the Training of Midwives and the Committee on Maternal Mortality, she served on the Health Committee of the League of Nations and rendered valuable service to international maternity and child welfare work during 1930–36. She also wrote a number of searching reports on her special subject. These led to many important reforms which have helped to reduce maternal and infant mortality in recent years.

She was created a D.B.E. in 1924, received the honorary degree of doctor of hygiene of the University of Durham, and was a justice of the peace for Surrey and for Gloucestershire. On her retirement in 1934 she married Mr. Michael Heseltine, registrar of the General Medical Council; he died in 1952.

Dame Janet was tall and good-looking. A somewhat reserved manner cloaked her enthusiasm for the cause to which she devoted her life, but those who knew her and worked with her fully appreciated her great qualities. ARTHUR S. MACNALTY

Mr. A. de C. Sowerby

ARTHUR DE CARLE SOWERBY, who died in Washington, D.C., on August 16, was a member of that branch of the Sowerby family which included such well-known scientific figures as James Sowerby, the artist-naturalist of "English Botany" fame, and James de Carle Sowerby, who was first secretary of the Royal Botanic Gardens in Regent's Park, London.

Arthur de Carle Sowerby was born in 1885 at Taiyuan-Fu, Shansi, and during an adventurous career accomplished much to promote the study of China's natural history, both as an explorer and as a writer. Among the expeditions in which Sowerby took a prominent part was a trip to Shansi and the Ordos Desert in 1908, with Mr. Malcolm Anderson, who was collecting mammals for the British Museum under the auspices of the Duke of Bedford's Zoological Exploration of Eastern Asia. This venture was successful and resulted in many new forms of mammals being collected and sent to the British Museum, where they were duly described and reported upon. In 1909 Sowerby, in the capacity of naturalist, accompanied Mr. Robert Sterling Clark to north-western China, and thereafter, up to the end of 1917, he travelled in northern and eastern China, Inner Mongolia and Manchuria, collecting on behalf of the United States National Museum in Washington.

These journeys and their scientific results have been described by Sowerby in the travel-books which he published between 1912 and 1930. Thus, the Clark Expedition was described in "Through Shên-Kan" (1912), written jointly with R. S. Clark. Perhaps the most important of these works by Sowerby is his "Naturalist in Manchuria", published in five volumes between 1922 and 1930, containing an account of the vertebrate and invertebrate fauna of the region.

In 1911 he organized and led the Shensi Relief Expedition during the Chinese Revolution, a mission which was successfully carried out after a journey of 2,000 miles.

After the First World War, Sowerby returned to China and busied himself with further explorations and collecting work in Fukien Province, and later made a biological survey of the country accessible from Shanghai.

In 1923 he founded the *China Journal of Science and Arts*, of which he was the editor for fifteen years. This valuable journal was a noteworthy contribution to cultural activities in Shanghai. It continued until 1941 and contains much valuable material on the natural history and antiquities of China, "handled", as Sowerby himself has expressed it, "in a more or less popular, but at the same time thoroughly authentic way".

He was also associated with the Shanghai Museum of the Royal Asiatic Society, becoming later honorary director of the Museum and president of the North China Branch of the Society from 1936 until 1940. He also helped to found the China Society of Science and Art, and the Numismatic Society of China, of which he was president. He was also president of the Naturalists' Club of Shanghai, founded in 1935, and to which he delivered the first presidential address, taking as his subject the "Progress of Biological Work in China".

He contributed many articles to scientific journals, newspapers, and to the *China Journal*. During 1943–49, the Heude Museum of Shanghai published several of his papers, the most considerable of which were probably his account of the birds of the Shanghai area, and a review of the mammals of the Japanese Islands, both of which were published in 1943.

Sowerby was interned by the Japanese in 1944, and when released, made his way *via* England to the United States, where he finally took up residence, in Washington, D.C. At the time of his death this genial and many-sided man was engaged upon a history of the Sowerby family, which he entitled "The Sowerby Saga". This was written in collaboration with his wife and a cousin, and the first three mimeographed parts appeared in 1952. In the first two parts of this work the origin and early and middle history of the Sowerby family are discussed, while the third part begins the story of Arthur de Carle's own life and activities down to 1912. It is to be hoped that it will be found possible to publish a further instalment of this vivid and interesting narrative. A. C. TOWNSEND

Mr. Talbot Peel

MR. TALBOT PEEL, whose death at the age of eighty-two occurred at Cambridge on September 17, had been a Fellow of Magdalene College for some forty-five years. Born on July 4, 1872, he was the son of Norris Peel, of Stonegarth, Huddersfield.

From Huddersfield College he proceeded to Magdalene College, where he was fifth Wrangler in the Mathematical Tripos (1893) and placed in the first class of the Mechanical Sciences Tripos (1894). He then went to C. A. Parsons, Ltd., Newcastle upon

Tyne, for a period of training in practical engineering, in particular on steam turbines, which were then in the early stages of development. He returned to Cambridge to take up a teaching post at the Leys School. Later he joined the staff of the Engineering Department of the University and, in 1909, was elected a Fellow of Magdalene College. Here he was director of studies in mechanical sciences and, for many years, bursar and steward, offices which he filled with enthusiasm and distinction. He was appointed to the Hopkinson lectureship in applied thermodynamics in 1930 and occupied that post until he reached the retiring age.

Peel's interests were by no means confined to the academic sphere; for example, he represented the University on the Borough Council for eleven years, was a member of the General Committee of Addenbrooke's Hospital and also served on the Finance Committee of the Evelyn Nursing Home.

His long connexion with the University and City of Cambridge was marked by never-failing courtesy and gentleness, characteristics which endeared him to all those with whom he came into contact. He is survived by his wife Elsie, *née* Penman, whom he married in 1914, and by their daughter Elizabeth.

J. Trevor Spittle

NEWS and VIEWS

Atomic Energy for Peaceful Purposes

On September 6, President Eisenhower announced that agreement had been reached between the United States and six other nations to establish an international agency which would foster the growth and spread of the new atomic technology for peaceful purposes. Atomic materials would be set aside for projects sponsored by the agency, and when arrangements were complete the United States would establish a reactor school to train representatives of friendly nations in the skills needed for their own atomic purposes. The United States was about to negotiate with the Belgian Government on the building of an atomic power reactor in that country, and discussions with Canada and with other countries that intended to build their own research reactor units would follow. President Eisenhower expressed the hope that no nation would stand aloof from such co-operation. Since then, at the General Assembly of the United Nations, Mr. Leslie Pearson, the Canadian Foreign Minister, on September 23 said that Canada believed that even without Soviet participation an international atomic agency along the lines proposed by President Eisenhower could usefully be formed, and Mr. Dulles, the American Secretary of State, affirmed the determination of the United States to implement the proposals originally made by President Eisenhower on December 8, 1953. Mr. Dulles indicated that it was now proposed to create an international agency the initial membership of which included nations from all regions of the world; to call an international conference next spring, under the auspices of the United Nations, to consider the whole subject; to open next year in the United States a reactor-training school where students from abroad might learn the working principles of atomic energy with specific reference to its peace-time uses; and to invite medical and surgical experts from abroad to participate in the work of American cancer hospitals, in which atomic energy techniques were among the most hopeful approaches to the control of this disease. No nation would be excluded from participation in this venture. On September 26, the State Department published without comment twelve notes, memoranda and aides-mémoire, exchanged in Washington and during the Berlin Conference in February between the United States and the Soviet Union, giving details of President Eisenhower's proposals of December 8, and showing how the two countries failed to reach agreement, but were still willing to continue the negotiations.

Journal of Nuclear Energy

Research work in the field of nuclear energy is now being carried out in many national establishments throughout Europe. Much of this work is of interest to nuclear physicists in general, but has perhaps tended to remain unpublished because of its specialized technical nature. The appearance of the quarterly *Journal of Nuclear Energy*, edited by J. V. Dunworth, J. Guéron and G. Randers, will therefore be welcomed not only by members of the official organizations, among whom it will circulate technical information, but also by many others with an interest in the experimental possibilities of nuclear reactors (London: Pergamon Press. Single issues 25*s*.; annual subscription, 4 issues, 90*s*.). The articles in the first number of the new *Journal* justify the claim of the publishers that it will "provide an outlet for papers dealing with the scientific, engineering, biological and economic aspects of nuclear energy". All these are represented, and at least two of the articles, those by C. A. Rennie on "Economic Power from Fast Breeder Reactors" and by J. F. Loutit on "Protection against Ionising Radiation", are of wide general interest. Although most of the papers in the first number come from Harwell, contributions from Kjeller (Norway) and Saclay (France) are included, and all are of a high scientific standard. The layout of the new *Journal* is attractive, and the printing and illustrations are of good quality; it deserves a wide circulation.

Communications and Electronics

A new British technical journal was launched in September under the title *Communications and Electronics*; it is intended to present monthly a review of the new practical applications of communications and electronic techniques, which are rapidly becoming one of the major industries in Great Britain. The purpose of this new journal is well illustrated in an introductory article in the first issue, by Sir Walter Puckey, who states that "the aim is to show other specialists what telecommunication and electronic systems can do, rather than how they work". Bearing in mind that these techniques are nowadays applied over a very wide range of industry and commerce, as well as to medicine and almost every field of research, this new publication may well fill a long-felt need. The scope is illustrated by the series of articles in the first issue. These deal on the radio side with such subjects as navigational aids in civil aviation, telecommunications at London

Airport, safety at sea, radio and allied techniques on British Railways, and with the present and future of colour television. Other articles provide a review of the present position of transistors, and of the significance of automatic computation in research, industry and commerce. There are also interesting sections of this issue dealing with "Electronics in Action" and "New Equipment and Components". The presentation and layout of the journal, with its excellent photographs, diagrams and explanatory charts, are of a high standard, and are a credit to the publishers, Heywood and Co., Ltd., Drury House, Russell Street, London, W.C.1; it is only available by annual subscription of £1 10*s*. for twelve issues, post paid (6 dollars in the United States and Canada).

Agriculture: Diamond Jubilee Number

STARTING as a quarterly publication in 1894, *Agriculture*, the now monthly journal of the Ministry of Agriculture, has maintained an unbroken and increasingly useful service to the farming community of England and Wales. Both the scope and influence of the journal have widened considerably since it first began, and it is now regarded as an authoritative source of scientific and practical information for farmers, market gardeners and fruit growers alike. The journal celebrated its diamond jubilee last September and the number for that occasion (London: H.M.S.O. 1*s*. net) contains various articles of interest, each contributed by specialists in the subject. The underlying theme is the progress made during the past sixty years in such fields as plant and animal nutrition and breeding, crop protection, horticulture and mechanization, and it is hard to realize how comparatively recent are many of the accepted practices of to-day. Other articles describe the changes that have taken place in Welsh agriculture, landownership and rural social conditions, while contributions of a more general nature deal with agricultural research, climate and the part played by agricultural societies, press and radio. Many readers will enjoy the personal touch provided by "I remember", a miscellany of recollections by some members of the older generation, and the beautiful illustrations depicting the varied nature of the English farming countryside.

Phyto-Sanitary Convention for Africa South of the Sahara

THE member governments of the Commission for Technical Co-operation in Africa South of the Sahara (Belgium, France, the Federation of Rhodesia and Nyasaland, Portugal, the Union of South Africa and the United Kingdom) have signed in London a Phyto-Sanitary Convention for Africa South of the Sahara. The objects of the Convention are to prevent the introduction of plant pests and diseases and other enemies of plants into any part of Africa south of the Sahara, to eradicate or control any that are at present in the area and to prevent their spread. It has established an Inter-African Phyto-Sanitary Commission on which each of the participating governments will be represented, and each participating government, as may be considered necessary by the Commission, will be required to exercise control of plant importations, and to apply measures of quarantine certification and inspection. It will also take any necessary action to deal effectively with diseases, insects, pests and other enemies of plants which have become or are likely to become a serious danger within the area, and to prohibit the importation of any plant material, seed or packing material which the Commission considers should be refused admittance into the area. The Commission is to have a scientific secretary and there is to be set up in London a Permanent Committee of Information consisting of the directors of the Commonwealth Institutes of Entomology and Mycology and the Scientific Secretary. This Committee will act as an intermediary between the two Commonwealth Institutes concerned and the African Phyto-Sanitary Commission for the transmission of relevant information about diseases, etc. The Convention will come into force as soon as it has been ratified.

Commonwealth Oceanographic Conference

A COMMONWEALTH Oceanographic Conference is to be held in the National Institute of Oceanography at Wormley, near Godalming, Surrey, during October 18–22. Australia, New Zealand, Canada, India and Pakistan are sending representatives, and observers will be attending on behalf of South Africa and Ceylon. Delegates from the United Kingdom will include representatives of the many government departments and scientific bodies interested in oceanographic research. The Conference has been arranged on the initiative of the National Oceanographic Council, to consider the possibility of closer co-operation in oceanographic research throughout the British Commonwealth. The need for such co-operation has become more pressing in recent years, as the tendency in oceanography has been to devote more and more effort to theoretical studies in an attempt to understand the fundamental physical and biological processes which are responsible for and cause variations in the properties of the waters, rather than to collect and analyse data concerning the water movements, temperature, chemical properties, distribution of marine life, etc., formerly the main activity. This change in approach has increased the difficulty of oceanographic laboratories in finding sufficiently qualified staff and providing the necessary facilities. The problems to be solved call for the attention of physicists of the highest calibre, and it will be a long time before any single country can interest an adequate number of such men in marine problems. Furthermore, it is becoming increasingly expensive to build, equip and operate a marine ocean-going research vessel. It is hoped that, as a result of the Conference, conclusions will be reached on the degree to which it is desirable for the Commonwealth countries to co-ordinate their oceanographic research programmes and to collaborate in solving outstanding fundamental problems.

City and Guilds of London Institute

THE growing importance of the City and Guilds of London Institute, and the part that it plays in advancing the cause of technical education, is the happy outcome of the enterprise of the Corporation and the Livery Companies of the City of London, which in this matter are acting fully in accordance with the tradition and past history of their respective organizations. In 1953 the Institute celebrated the seventy-fifth anniversary of its incorporation. Its progress during 1953 is described in the annual report, which contains an account of the successful launching of an appeal for £100,000 in order that the Institute could more readily meet increasing demands by industry and commerce. One of the outstanding events of 1953 was an unexpected rise in the number

of candidates who sat for the City and Guilds examinations. The steep rise over the years 1941–50 was followed by only moderate increases in 1951 (834) and 1952 (1,479). In 1953 there was a sharp increase of 4,336, the number being fairly evenly spread over most established subjects.

Another important development in 1953 was the establishment of a new examining body provisionally entitled the Joint Examinations Board for the General Certificate of Education. This body will offer examinations having a bias towards the particular needs of pupils in secondary technical, commercial and modern schools and classes and the needs of students in institutions for further education. The Institute has undertaken, during the initial stages, the administrative and financial responsibilities of the Board, of which it is one of the sixteen sponsoring bodies.

Properties of 'Nimonic 95'

A recent addition to the well-known series of 'Nimonic' alloys is discussed in a technical publication of Henry Wiggin and Co., Ltd., Thames House, Millbank, London, S.W.1. The highest creep resistance is normally obtained by solution-treating the alloy for 4 hr. at 1,150° C., or, if a coarser grain size is not a serious matter, for 1–2 hr. at 1,200° C. This is followed by reheating for 6–8 hr. at 1,080° C., followed by 16 hr. at 700° C. In each case the sample is air-cooled after the treatment. Among the high-temperature properties which are given, the 0·1 per cent proof stress, which is 51 tons/sq. in. at ordinary temperatures, is still 43 tons at 700° C., 17 at 900° C., and 4·1 at 1,000° C. The corresponding figures for the elongation per cent, measured on four times the square root of the area, are 25, 4·5, 11 and 59, the modulus of rigidity being 30, 25, 18 and 14 × 10^6 lb./sq. in. At 870° C. the endurance under a stress of 20 tons/sq. in. is 10 × 10^6 cycles, and at 16·8 tons 45 × 10^6 cycles in about 300 hr. Among the creep data given the following figures may be mentioned: under a stress of 8 tons/sq. in., a creep extension of 0·2 per cent occurs in 10,000 hr. at 750° C., at a stress of 7·5 tons at 815° C. in 1,000 hr., and under a stress of 4 tons/sq. in. in the same time at 870° C. Rupture under creep in 1,000 hr. occurs under stresses of 16, 8·5, 5·5 and 2·2 tons/sq. in. at temperatures of 750, 815, 870 and 925° C. respectively.

Gamma-Ray Sources for Radiography

A revised second edition of the "Memorandum on Gamma-Ray Sources for Radiography", first published in 1952 (see *Nature*, 170, 186; 1952), has recently been issued (pp. 28. London: Institute of Physics, 1954; 3*s*. 6*d*.). As previously, it has been prepared by a committee of the Non-destructive Testing Group (formerly the Industrial Radiology Group) of the Institute of Physics. The physical characteristics of gamma-ray sources, with particular reference to the products of the Atomic Energy Research Establishment, Harwell, and of the Radiochemical Centre, Amersham, are summarized, and attention is directed to radiographic technique, protection of personnel and to the costs involved. The subject-matter has been brought up to date and has been extended in many respects, particularly with regard to the number of radioactive materials considered. For industrial radiography, sources consisting of the naturally radioactive gas radon-222, which is of high activity and small bulk, and cæsium-137, can be obtained from Amersham, and artificially radioactive sources—cobalt-60, tantalum-182, iridium-192 and thulium-170—from Harwell; in addition, the shorter-lived sodium-24 and gold-198 sources can be supplied from Harwell when specially ordered. One section of the memorandum deals with the sizes of sources and the design of source capsules, and in another an outline of gamma-ray radiographic technique—which, it is pointed out, is similar to that of X-rays—is given with references to further details. Other sections deal with the protection of personnel, the handling and transport of sources and the cost of installing equipment for gamma-ray radiography. The memorandum concludes with a comprehensive and useful bibliography and with data sheets for each of the longer-lived radioactive sources mentioned above. The data are reproduced from official sources.

Cotton Growing in Northern Nigeria during the Season 1952–53

The progress report for the season 1952–53 from the Experiment Stations in Northern Nigeria of the Empire Cotton Growing Corporation (pp. 19. London: Empire Cotton Growing Corporation, 1954; 9*d*.) reports that, following the previous season's record yield of 113,510 bales of cotton, 17 per cent more seed was issued, although not all was planted, and some, which was taken by inexperienced cultivators, gave very little return. Early rains made cotton planting unduly late, and confidence induced by the easily obtained good yields of the previous crop led to less attention to planting and weeding. In consequence, the crop for export was only 95,445 bales, and the average return per ton of seed fell from 10 to 7 bales of lint. At Samaru, in Zaria Province generally and in some other areas yields were as good as in the 1951–52 season; the growth of the industry in the Gombe area (Bauchi Province) has been remarkable and is clearly capable of expansion. Yields in South Katsina were well below those of the previous season. Rainfall at Samaru was unusually heavy in July, well below normal in August, and about normal in total and in time of cessation (October). The growth of the crop was in general satisfactory. Insect damage was not unduly severe, that attributed to mirids (*Campylomma* and/or *Lygus* spp.) being less than in the two previous seasons. Red bollworm populations were lower except at Kontagora and Yola, and pink bollworm was higher than elsewhere at Yola and Gombe. Good control of *Campylomma* and a marked reduction in leaf tattering was achieved at Samaru by late spraying with 1 per cent DDT emulsion, and at Daudawa treatment with DDT emulsion gave a 50 per cent increase in the yield of clean seed cotton. Bacterial blight (*Xanthomonas malvacearum*) was more in evidence than in 1950–51 or 1951–52, and it seems probable that this disease in its several manifestations can be responsible for much damage to bolls, although differences between strains in the severity of symptoms displayed are not related obviously to differences in yield.

Manganese and Metabolism in Potatoes

The importance of manganese in plant metabolism, though now established, is but little understood. In a study of the effect of manganese on the assimilation and respiration-rate of isolated rooted leaves of the potato, H. C. Ruck and B. D. Bolas (*Ann. Bot.*, N.S., 18, 71, 267; 1954) have found that normal potato leaves will root readily after treatment with α-naphthaleneacetic acid (2 p.p.m.) but

that very few manganese-deficient leaves will respond in this way, the critical level being about 15 p.p.m. manganese on a dry-weight basis. The growth of the manganese-deficient leaves was also less, but they did not develop the characteristic symptoms of this mineral deficiency, even when the level had fallen below that at which symptoms would have appeared on attached leaves. In leaves which had a high or a low manganese content at the time of rooting there was a marked difference in the net assimilation-rate; but the addition of manganese after rooting to leaves of low content did not increase the assimilation-rate. The effect of manganese content on respiration was found to be slight, though a higher respiration-rate was consistently associated with a higher manganese content. No effect on translocation was detected. The authors point out that the effect of manganese on the assimilation apparatus may occur during the development of the leaf and that once the chloroplast system has become fully developed any manganese deficiency which develops during that phase cannot afterwards be made good. They also indicate, however, that the capacity for chlorophyll formation in deficient leaves is not lost, since considerable greening can be produced by injection, provided the manganese deficiency has not become too advanced.

The National Museums, Ceylon

THE administration report of the National Museums, Ceylon, for 1953 records the activities at Colombo, Kandy, Ratnapura and Jaffna. It is interesting to note that at the Colombo National Museum an annual attendance of 207,438 included 35,171 schoolchildren in organized groups. The acquisition of the only known incisor tooth of *Rhinoceros sinhaleyus* and a series of bone implements, including some notched for attachment to hafts from cave deposits, is reported. On the proposal of the Director, the Colombo Museum Committee decided to conduct a speleological survey of Ceylon to include the zoology and prehistory of all the caves in the Island. Accordingly, a Speleological Association of Ceylon, the membership of which is open to the public, was formed in July 1953.

Swedish National Committee for Physics

THE seventh general physics conference of the Swedish National Committee for Physics was held at the Chalmers Institute of Technology, Gothenberg, during September 28–30, 1953. The director, Prof. Nils Ryde, gave details of the facilities available at the Institute and described the research work in progress, and Prof. S. Eklöf spoke about the organization of teaching and research in the Electrical Engineering Department. Several distinguished visitors from outside Sweden attended the conference and gave addresses. These included Dr. M. Edlund (Oak Ridge Laboratories), who gave a survey of recent reactor developments in the United States; Prof. T. W. Bonner (Rice Institute, Houston), who lectured on excited states of light nuclei; and Dr. A. Bohr and Dr. T. Huus (Copenhagen), who spoke about rotational states of atomic nuclei and the Coulomb excitation of heavier atomic nuclei, respectively. Summaries of the other forty-six papers contributed to the conference are printed in *Arkiv för Physik*, **8**, 1; May 1954. They include several contributions from the Atomic Energy Laboratory, Stockholm, and from the Nobel Institute of Physics, Stockholm.

The Nature Conservancy: Awards for 1954

THE Nature Conservancy announces the following awards of research studentships for postgraduate training in ecology, tenable for periods of up to three years at the universities and other institutions named: *Botany:* A. P. Hughes (Trinity Hall, Cambridge); E. Lodge (University College, London); N. M. Pritchard (Balliol College, Oxford); T. O. Pritchard (Leeds); V. I. Stewart (Aberdeen). *Zoology:* J. M. Colebrook (Freshwater Biological Association, Far Sawrey, Ambleside); J. C. Coulson (Durham); J. B. Ford (Southampton); Miss T. J. White (Imperial College of Science and Technology, London).

Announcements

THE Council of the Royal Society has appointed Prof. M. L. E. Oliphant, of the Australian National University, as the Rutherford Memorial Lecturer for 1955. Prof. Oliphant will deliver lectures in India and Pakistan.

THE 1954 Eddington Lecture is to be given in Cambridge, at the Arts' School Lecture Theatre, Bene't Street, on November 2, at 5 p.m., by Prof. H. Dingle, professor of the history and philosophy of science in University College, London. Prof. Dingle will speak on "The Sources of Eddington's Philosophy".

THE War Office announces that Prof. S. J. Davies has been appointed dean of the Royal Military College of Science, Shrivenham. Prof. Davies is professor of mechanical engineering in the University of London at King's College, and will retain his chair until the end of the present academic year.

DR. E. H. SONDHEIMER, lecturer in mathematics in the Imperial College of Science and Technology, London, has been appointed to the University readership in applied mathematics tenable at Queen Mary College, University of London.

THE Metallurgical Laboratories of the British Welding Research Association are holding open days on November 23 and 24. Admission will be by ticket, obtainable from the Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

REFERRING to the article on "The Golgi Apparatus" (*Nature*, July 3, p. 21), Mr. Dennis Lacy writes: "I may inadvertently have given the impression that the views of Dr. J. R. Baker and his colleagues are based solely upon the study of only three different cells (neurones of *L. migratoria*, epithelial cells of the intestine, and Paneth cells). They have indeed published careful accounts which deal specifically with the Golgi problem in nineteen different kinds of cells".

ERRATUM. In the article on the report for 1953 of the Rothamsted Experimental Station (*Nature*, September 11, p. 498), referring to the work of the Bee Department, it is said that the fumes produced by adding small quantities of ammonium nitrate to burning smoker fuel provide a simple anæsthetic for use when transferring bee colonies from one site to another a short distance away, since on recovery it is claimed that the bees lose their tendency to drift back to the original site. It should have been added that the Rothamsted work has failed to substantiate this claim, but it is considered that the method, provided that the minimum proportion of ammonium nitrate to fuel is used, is the most efficient and simple one so far suggested for anæsthetizing whole colonies of bees *in situ*.

USE OF SCIENTIFIC DEVELOPMENTS IN INDUSTRY

TWO papers given before Section F (Economics) of the British Association at Oxford on September 7 supplemented the account of the work of the Science and Industry Committee included in the first report of the Committee on Human Relations in Industry issued last June (see *Nature*, **174**, 49; 1954). In the first of these, Prof. C. F. Carter gave a brief account of the way in which the interest taken in the work of the committee originally set up by the Council of the British Association at the Belfast meeting in 1952 to study "the problems of speeding up in industry the application of the results of scientific research" had led last spring to the reconstitution of the committee under the joint sponsorship of the British Association, the Royal Society of Arts and the Nuffield Foundation. Prof. Carter, emphasizing that the situation is changing and requires constant reassessment, explained the way in which the Committee has sought both to obtain an overall view of the relative importance and the interrelations of the various factors and of the way in which it operates in particular firms. It has attempted, for example, to collect further information as to the validity of the view that British industry is inadequately supplied at the higher management or directorate level with persons with scientific and technical knowledge, and to elucidate the question whether the use of scientific knowledge is being impeded by restrictive practices on the part of management, the latter with the view of weakening or strengthening the suspicion that it does not pay to be quick in exploiting new scientific discoveries or methods.

The first year was spent in preliminary planning, in securing funds and in recruiting staff, and Prof. Carter did not attempt to give an interim report on the Committee's conclusions even during its second year's work. He remarked that certain possible hindrances to the use of science which *a priori* looked important have obstinately failed to appear in the case studies so far conducted. The attitude of industry to science is unlikely to be the mechanical result of a set of material factors. While such matters as the shortage of scientists or of equity capital, the influence on investment of the size of firms, or the proportions of management with certain qualifications, though very troublesome to investigate, can be reduced to questions of fact which are precisely defined, at every point questions of fact are inextricably mixed with those of attitude. The demand for scientists, for example, depends on the attitude of different types and sizes of firms as to the usefulness of employing scientists, and this depends on a general climate of opinion. So, too, the effect of taxation on the utilization of scientific knowledge is the resultant of the different ways in which the same taxation system causes different people to act; nor did Prof. Carter venture to predict how much the Science and Industry Committee could add to knowledge on a matter which involves these puzzling problems of attitude.

Prof. B. R. Williams's paper explained the methods employed by the Committee in the studies it has sponsored of the action of particular firms facing particular opportunities in new applications of science. Like Prof. Carter, he emphasized the willingness of firms to co-operate and the great interest taken everywhere in the work of the Committee. Following a first attempt to obtain information on the origin of both successful and unsuccessful developments, the difficulties encountered and the time scale as well as, for new products, the particular sales problems, the Committee hopes to investigate more fully some fifty firms with the view of obtaining further insight into what determines the rate at which new products or processes are created and taken up. For this purpose a rough classification of problems has been attempted into those of communication and conversion generally, those due to the structure of the relevant industry, and those due to the structure of British industry.

Only one inquiry is almost complete at this stage—that into the rate at which, and means by which, tunnel kilns and kiln furnitures have been improved in the pottery industry. Here tunnel kilns which, when working properly, give significant savings of fuel, labour and wasted ware and facilitate the flow of work within the factory, were taken up very slowly until after the War, since when a large number had been installed. Prof. Williams said this can be attributed to four main factors. The pottery industry is in large measure a craft industry with a craft attitude to the job as a whole and great suspicion of new-fangled methods. Costing methods are primitive or non-existent. The large amount of space required by tunnel kilns involves extensive building, and this is a great impediment when output is not expanding and profits are very low. The small firms predominating in the industry have difficulty in financing rebuilding and installation when profits are low, and are reluctant to raise capital in a way that endangers family succession. The increased installations since the War can be traced to the breakdown of some of these impediments.

Commenting generally on the investigations, Prof. Williams stressed the value of such inquiries sponsored by a body constituted like the Science and Industry Committee. The Committee has facilitated deployment of the expert knowledge and experience of its members without subjecting them to intolerable strain. The method employed in the second stage inquiries works best with firms that have squarely faced the application of science to industry, and particularly with firms large enough to maintain an organization for that purpose. He emphasized the need for caution in generalizing direct from the peculiar conditions of the post-war period and also in judging whether a firm is reasonably fast or unreasonably slow in the industrial application of science. The firm which most impressed him with the speed and whole-heartedness with which it applied science to industry had only been saved from bankruptcy recently by a manager who insisted on cutting research and development far below the level at which he found it; in consequence, the firm will probably soon be spending more on research and development than before its near bankruptcy.

ATOMIC LINE SPECTRA

IN the course of a long history, the branch of physics concerned with the study of optical spectra has been exceedingly fruitful of fundamental results and concepts, and in application. A period of remarkable advance—the golden age of the interpretation of line spectra and extranuclear atomic structure—extended over little more than ten years following the First World War. At the opening of that period, a number of significant regularities had been found empirically in, for the most part, the simpler series spectra, by diligent efforts of a number of workers subsequent to Balmer's discovery, in 1885, of the distribution law of the hydrogen line series which bears his name. In addition, Bohr had produced his postulates for hydrogen-like atoms in 1913, and calculated the Rydberg constant. However, the spectra of most elements consisted of bewilderingly large numbers of lines having little apparent order. The great achievements of the early 1920's resulted from application of the Bohr theory and its elaboration, at the hands of Bohr, Sommerfeld, Landé, Pauli, Russell and others, into the older quantum theory and vector model, and from the provision, in 1922, of the key to the analysis of complex spectra by Catalán's paper on the arc spectrum of manganese. Simultaneously, development of a theoretical background capable of coordinating much of the accumulated observational material stimulated vigorous laboratory investigations, aimed at improved accuracy and methods.

Later in the 1920's, the formulations of quantum mechanics removed much of the *ad hoc* appearance of the older theory. Achievement was, in fact, so rapid and extensive that, by the beginning of the decade following, the impression was widespread that study of atomic spectra had become, in essence, a closed field; correspondingly, though with notable exceptions, the vigour of laboratory investigations faded, and the number of active workers declined. The view that a particular field is exhausted of further basically important discoveries is of a risky nature; in the case of line spectra, much of fundamental interest may repay investigation of the finer details of even, at present, well analysed spectra. In some cases—for example, those of the complicated rare-earth and transuranic spectra—little more than a start has been made in analysis. Measurements of line intensities and oscillator-strengths, while of fundamental significance, are beginning to receive the attention needed largely because of the demands of the astrophysicist. A similar position is probably arising regarding Stark and other line-broadening effects, in relation to spectroscopic study of discharge plasmas. Again, interconfiguration interactions and autoionization phenomena are little understood—and the theme can be developed.

The present position and current directions of work on atomic spectra received excellent demonstration at the recent "Rydberg Centennial Conference", held during July 1–5 in the Physical Laboratory of the University of Lund. The meeting was organized, under the auspices of the International Union of Pure and Applied Physics, by the Swedish National Committee of Physics, and marked the centenary of the birth of Johannes Robert Rydberg (1854–1919). Rydberg, while holding the chair of physics at Lund, successfully applied a genius for the handling of numerical data to the search for regularities in line spectra.

The conference met under the presidency of an eminent contributor to line-analysis, Dr. W. F. Meggers, of the U.S. Bureau of Standards, and owed much for initiation and excellence of organization to Prof. B. Edlén, the present occupant of Rydberg's chair, whose work on the spectra of stripped atoms and of the solar corona is renowned. During the four days a total of more than sixty papers was read, most centres of currently active research on line spectra being well represented.

The proceedings of the first day, devoted to the general structure and analysis of atomic spectra, were distinguished by review addresses by N. Bohr (Copenhagen) on "Rydberg's Discovery of the Spectral Laws", W. Pauli (Zurich) on "Rydberg and the Periodic System" and A. G. Shenstone (Princeton) on "Series in Line Spectra". B. Edlén (Lund) discussed improvements in spectral series representation, and showed that all series in alkali arc spectra and in Ca II can be accurately represented by addition of one or two terms to the usual Ritz denominator. Present accepted values of the ionization potentials of ions up to the nineteenth stage were reviewed by W. Finkelnburg (Erlangen), who indicated improved methods of extrapolation along isoelectronic sequences. C. C. Kiess (Washington) described results of the analysis of Mo II; with the aid of new wave-length and Zeeman effect observations, 80 per cent of the observed lines are classifiable. The analyses of Os I and II, utilizing Zeeman patterns at 85,000 gauss, were discussed by J. C. van den Bosch (Amsterdam). Papers by S. Glad (Lund) and by O. Garcia-Riquelme and R. Velasco (Madrid) described work on the astrophysically important spectra of Fe III and Ni III, respectively. In dealing with complicated spectra, search for real constant-frequency intervals is extremely time consuming; in this connexion L. F. H. Bovey (Harwell) discussed the applicability of standard computing equipment to term analysis.

A number of interesting papers on methods and results of high-resolution spectroscopy were presented during the second and third days. H. Kopfermann (Heidelberg) reviewed past contributions and present trends of investigations on optical hyperfine structures and isotope-shifts in relation to nuclear properties, namely, spin, magnetic and quadrupole moments. This kind of work has always made great demands on instrumental refinement and technical skill; the elegance of some of the experimental arrangements outlined indicated that progress in these respects continues. Thus, P. Jacquinot (Bellevue, S. et O.) described a recording Fabry–Perot interferometer which employs a photomultiplier or photo-conductive detector placed behind an annular exit-slit, upon which the ring system is focused concentrically; scanning of the pattern is performed by moving the fringes across the slit, by cyclic variation of either the gas pressure in the interferometer housing or of the étalon spacing. This type of instrument has been used by H. Chantrel, who reported an investigation of the abundance-ratio of lead and neodymium isotopes and a determination of the quadrupole-moment of mercury-201, and by J. Blaise, who described results on hyperfine structure, in Pb I and II and the first measurement of a hyperfine structure pattern of a line lying beyond the photographic limit in the infra-red. Other work of high refinement consisted in combination of an atomic-beam light source and a large-gap étalon; described by K. W. Meissner (Lafayette, Ind.), this apparatus

has been used to obtain wave-lengths of eight lines of germanium to an estimated $\pm 4 \times 10^{-5}$ A. Successful measurements of very small isotope shifts in Sn II and Cd II were reported by H. G. Kuhn (Oxford); in this work enriched isotope samples were employed. E. Rasmussen (Copenhagen) gave results on isotope shifts in krypton; here, the isotopes, separated in a mass-spectrometer, were collected on aluminium foil from which the gas could afterwards be released by radio-frequency heating. Description of the measurement of isotope shifts in the spectra of the lightest elements by J. E. Mack (Madison) included a discussion of their interpretation in terms of the specific mass contribution. Work at Amsterdam on the spectra of plutonium-239 was described by P. F. A. Klinkenberg; high-resolution studies have led to the conclusion that this isotope has a nuclear spin of $\frac{1}{2}$. High-resolution work at the Oak Ridge Laboratories of the U.S. Atomic Energy Commission, described by J. R. McNally, has included isotope-shift and abundance studies in the heavy elements and transuranics; for example, uranium-233 and 235 were stated to have probable nuclear spins of 5/2 and 7/2, respectively. Two papers were concerned with the important topic of the Lamb–Retherford shift, both being marked by the skill of the techniques employed. G. W. Series (Oxford) had studied the fine structure of He II λ4686, using two étalons in series and a discharge-tube cooled in liquid hydrogen; he reported that the results departed appreciably from Dirac theory expectations, and possibly also showed a smaller departure from predictions of the new quantum electrodynamics. G. Herzberg (Ottawa) described measurements of the wave-length of the first line of the Lyman series of deuterium; for this work, the fifth-order of a three-metre vacuum grating was employed, and the line obtained in absorption by the partially dissociated gas drawn from a Wood tube; again, there are indications that the shift of the ground-level of deuterium shows a small departure from theory.

A welcome feature of the conference was the presence of a number of prominent workers on theoretical spectroscopy—this especially since the most recent monograph available is the monumental effort of Condon and Shortley, now some twenty years old. The scope of current theory applied to actual classification problems was reviewed by G. Racah (Jerusalem), with particular mention of complex ($l^m d^n$-configuration) and very complex ($l^m f^n$-configuration) spectra. Several papers referred to features of two-electron spectra; E. A. Hylleraas (Oslo) gave results of new calculations of singlet and triplet series, and P. Pluvinage (Strasbourg) presented new results for the ground-state and first-excited state of He I. The interesting question of the effect of interconfiguration interaction in He I-like spectra was dealt with by L. C. Green (Haverford, Pa.). L. Biermann (Göttingen) reported theoretical calculations of f-values, and directed attention to the importance of interconfiguration perturbations; thus, in the case of the singlet resonance line of Ca I, the theoretical value of $f = 2{\cdot}2$ is reduced to 1·48 when the effect of $4pmp$ terms is included.

Several papers formed general or specific reports on laboratory methods. Infra-red atomic spectroscopy was comprehensively reviewed by C. J. Humphries (Corona, Cal.) with particular emphasis on the use of modern photoconductive detectors; the certain usefulness of these techniques in the investigation of rare-earth spectra was indicated. R. A. Fisher (Evanston, Ill.) described a use of Edser–Butler fringes for facilitating wave-length calibration of recording spectrometers. Experience with the use of multilayer highly reflecting films on Fabry–Perot plates was described by F. A. Jenkins (Berkeley). In a paper on stigmatic concave gratings, F. Zernike (Groningen) proposed the novel solution of replacing the usual straight ruling by a system of concentric circular arcs. E. Hulthén (Stockholm) described experiments made with plane gratings immersed in liquids as a means of raising resolving power and dispersion. Several developments of light sources were described; for example, convenient forms of demountable hollow-cathode tubes (H. Schüler, Hechingen), the 'vacuum sliding-spark' (N. Astoin and B. Vodar, Bellevue) and the pulsed high-frequency electrodeless discharge (L. Minnhagen, Lund). All these sources are useful in the study of spectra of the lower ionization stages, the 'sliding spark' being the most energetic; the use of this source was illustrated by K. Bockasten (Lund) for C III and IV.

The study of line intensities and f-values was well represented. W. F. Meggers (Washington) reported measurements of arc intensities of 30,000 lines from seventy elements introduced as small admixtures in a base of powdered copper; copper lines used as intermediate intensity standards were finally compared with radiation from a tungsten lamp. Use of a King furnace at Amsterdam, for measurement of relative f-values of Fe I lines, was described by C. J. Bakker. The promising technique of rotation-stabilized arcs, which makes possible the realization of a portion of matter in thermal equilibrium at a temperature of up to 50,000° K., was described by H. Maecker (Erlangen). R. H. Garstang (London) reviewed theoretical computations of atomic transition probabilities, and presented the results of his own calculations and their comparison with experiment.

The final day of the conference was occupied with papers on miscellaneous experimental topics, compilations of data, and astrophysical applications. Autoionization phenomena were discussed by W. R. S. Garton (London) in connexion with vacuum ultra-violet absorption spectra. Two papers dealt with elegant experimental techniques developed at the École Normale Supérieure, Paris. A. Kastler described applications of a method involving optical detection of the partial spatial orientation produced in an atomic beam which is subjected to a perpendicular magnetic field and, parallel to this, a beam of circularly polarized resonance radiation. J. Brossel and J. E. Blamont described measurements on the Stark effect of the $6\ ^3P_1$ state of Hg I, based on observation of the change in the magnetic resonance curve following superposition of an electric on the main magnetic field. Statistical Stark broadening in the spectra of discharge plasmas was discussed by W. Lochte-Holtgreven (Kiel), with particular reference to determination of ion concentrations in the high-power arcs developed at Kiel. L. Herman (Bellevue) compared experimental and theoretical contours of Balmer series lines exhibiting strong ionic Stark broadening. Use of a statistical theory, based on a Lennard-Jones potential function, was suggested by B. Vodar (Bellevue) to account for the results of experiments on the shifts of resonance lines of the alkalis, mercury and xenon, occasioned by high pressures of foreign gases. Features of time-resolved spectra of long sparks in air, and of pulsed centi-

metre-wave discharges in rare gases, were described respectively by A. Vassy (Paris) and by I. Eyraud and J. Janin (Lyons). Measurements of wave-length standards by means of a reflecting échelon were described by T. A. Littlefield (Newcastle), who directed attention to the necessity for certain corrections; P. Risberg (Lund) explained the establishment of accurate vacuum ultra-violet wave-length standards by application of the combination principle to newly measured long wave-length lines of Mg II and Ca II.

Mrs. C. E. Moore-Sitterly (Washington) spoke on one of the several valuable compilations of data for which all spectroscopists are indebted to her, namely, a second revision of Rowland's Solar Wave-length Table. Announcement of the preparation of a useful table of forbidden multiplets of astrophysical significance was made by J. W. Swennson (Liège). Of the specifically astrophysical papers, that of E. Finlay-Freundlich (St. Andrews) on his well-known hypothesis in explanation of the general red-shift in celestial spectra produced much discussion; the possibility of fluorescence by line-coincidence was illustrated by J. Gauzit (Lyon), and Mrs. C. Payne-Gaposchkin (Cambridge, Mass.) contributed results of a spectrometric study of a rotating star. The conference ended with a general discussion, under Prof. Edlén, concerning proposals for defining the metre in terms of the wave-length of a chosen spectral line produced under specific conditions.

Limitations of space preclude a fuller account of the many important contributions to this conference, which demonstrated that the study of line spectra continues to flourish.

W. R. S. Garton
L. F. H. Bovey

RIDERLESS MICROCHEMICAL BALANCES

At the recent symposium on analytical chemistry held in the University of Birmingham by the Midlands Society for Analytical Chemistry, one of the most interesting features in the display of modern laboratory apparatus was the adoption of the riderless beam principle by the firm of L. Oertling, Ltd. (Cray Valley Road, St. Mary Cray, Orpington, Kent), in the construction of its two new microchemical balances.

There is little doubt that one of the most serious sources of error in weighing on a microchemical balance (apart from the personal factor) is associated with the use of the rider. These errors have been attributed to variations in the mass of the rider, its angular placement on the beam, the shape of the notch and the accurate location of the notches on the beam. The cumulative effect of these errors over the several weighing operations involved in a gravimetric analysis may result in considerable inaccuracy. Some workers have estimated the probable error of any one reading on a microchemical balance at $\pm$ 3 μgm., while work undertaken for the American Chemical Society by others gave values of 0·9–23·3 μgm. for the standard deviation of thirty-two different microchemical balances used with a 1-gm. load. The elimination of every possible source of error is therefore highly desirable.

Few fundamental advances have been made in the design of microchemical balances since the evolution of the original Kuhlmann model, but the elimination of the rider error in these two new microbalances by Messrs. Oertling will undoubtedly be hailed as such by many.

In place of the conventional rider system, a plain beam is used in conjunction with a series of fractional rider weights. These fractional riders are loaded on to a special carrier bar, attached to the pan-suspension system, by means of levers operated by a calibrated dial attached to the right-hand side of the balance case. In the more sensitive of the two balances, these fractional riders have a displacement value equivalent to 9 mgm., so that when the 1-mgm. range of the graduated optical scale is added, a total displacement of 10 mgm. can be observed, rendering the use of weights less than 10 mgm. superfluous.

Needless to say, the possibility of errors of another nature is introduced by the riderless beam principle, and one still has to reckon with variation in the weights of the fractional riders; but nevertheless weighing operations are speeded up considerably, and the inherent errors involved would seem to be less serious, for the manufacturers claim that for the first time in microchemical weighing it is possible to weigh with certainty to the nearest microgram.

T. S. West

ACTIVITIES OF THE INTERNATIONAL UNION OF BIOLOGICAL SCIENCES

The Policy Board of the International Union of Biological Sciences met in Paris during June 28–30 and made a number of recommendations regarding the future structure of the Union. The Board consisted of Prof. P. Weiss (United States) and six other members: Prof. A. Frey-Wyssling (Switzerland), Prof. J. Monod (France), Dr. L. Harrison Matthews, representing Prof. C. F. A. Pantin (United Kingdom), Prof. B. Rensch (German Federal Republic), Prof. John Runnström (Sweden) and Prof. M. J. Sirks (Netherlands); a number of officers of the Union and of other International Unions were also in attendance for parts of the meeting. One of the principal recommendations was that the Union should consist of eleven Sections, as follows: Biochemistry, Biometry, Botany, Cell Biology, Developmental Biology (including embryology), Ecology (including limnology), Genetics, Microbiology, Physiology, Experimental Psychology and Zoology (including entomology). This would involve setting up four new Sections—those of Biochemistry, Developmental Biology, Physiology and Experimental Psychology—and incorporating the present Sections of Embryology and Entomology as indicated.

The work of the Union is of a varied nature. Research institutes available to workers of all nationalities have been supported or founded: for example, a culture collection of wild species of *Drosophila* at Pavia; Centres for the Biological Control of the Pests of Plants at Geneva and Mentone; the International Depot of Microscopical Preparations at Louvain; the International Bureau of Human Heredity at Copenhagen; and the Serological Museum at Rutgers University, New Brunswick. The Union organizes and partly finances symposia for the discussion of current research

(usually three a year) by small groups of specialists, and also helps in the organization of international congresses relevant to its work. Catalogues of types in national museums, and a list of type-genera and species of mites have been published, thanks to financial aid from the Union, and annual grants have been made to certain periodical publications of an international character concerned with bibliography, such as the *Zoological Record*, *Biological Abstracts*, *l'Année Biologique* and *Resumptio Genetica*; the publications of the International Commissions for Zoological Nomenclature, Botanical Nomenclature and Bacteriological Nomenclature have also been supported financially.

The officers of the Union are as follows: *President*, Prof. S. Hörstadius (Sweden); *Vice-President*, Prof. R. E. Cleland (United States); *General Secretary*, Prof. G. Montalenti (Italy); *Secretary*, Prof. R. Ulrich, France (Laboratoire de Physiologie Végétale, 1 rue Victor Cousin, Paris 5e); and *Treasurer*, Prof. A. Linder (Switzerland). Publications of the Union are available from the secretary, Prof. Ulrich. All other communications should be directed to the general secretary, Prof. G. Montalenti, at the headquarters of the Union, Istituto di Genetica, Via Mezzocannone 8, Naples.

CRYSTALLINE BACTERIAL ARRAYS AND SPECIFIC LONG-RANGE FORCES

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THE purpose of this communication is to show that, like viruses, some bacteria can be crystallized. The bacterial cells form regular three-dimensional arrays in which each cell corresponds to a molecule in a conventional crystal; with rod-shaped bacteria, the rods are parallel.

This helps to bridge the gap between the microscopic and the molecular. For the first time it is possible to see easily with the light microscope particles which behave in some respects like molecules. This can be done when they are in their natural medium, without drying as required for the electron microscope.

There is reason to think that specific forces may operate over distances much greater than the range of ordinary valency forces. While the work of Rothen[1] remains controversial and has been to some extent disproved[2,3], it is undisputed that in suspensions of bentonite[4], solutions of tobacco mosaic virus[5] and of some other colloidal substances[6], individual particles are under certain conditions held orientated parallel to one another when the distances separating the particles are as large as several hundred angstrom units. The largest spacing so far recorded is 8000 A. in the Schiller layers of iron oxide[7]. As Bernal[8] has said: "There is evidence that between extended particles there are forces which act at distances of the same order as the size of the particles themselves". In the bacterial aggregates to be described the forces appear to operate over distances of 10,000–50,000 A. Regular arrays were obtained both in two dimensions and in three.

(*a*) *Two-dimensional arrays.* During work on *Amoeba proteus* in hanging drops of Chalkley's[9] medium—a very dilute balanced salt solution—it was noticed that fine parallel striations appeared on the surface, especially if the drops were set aside for a few days. These gave brilliant diffraction colours with the light from the condenser, and on close inspection the striations were found to be made up of thousands of parallel bacterial rods. These bacteria occurred naturally in association with the amoebæ and multiplied after the amoebæ cytolysed. Stirring with a micromanipulator disorientated the rods, but after the removal of the needle they rapidly became parallel again. This shows that the orientation was not due to adhesion of the cells after division. Small islands containing about thirty parallel rods sometimes occurred. These were in dynamic equilibrium with the free individual bacteria in the solution, which were highly mobile either due to locomotor organs or lively Brownian movement. Bacteria approaching an island were captured, and snapped parallel to the rest of the group, and others broke free from time to time elsewhere and escaped into the solution. A cell prized off by the micromanipulator by more than 5 μ from the edge of the island would swim away freely in the solution.

In regions of the surface where the cells were not parallel, they could be made to become so by stroking with a micromanipulator needle, and the influence spread far beyond the area stroked. This recalls the scratching technique used by chemists to induce crystallization in a supersaturated solution. A needle placed in the surface of the drop induced the cells to arrange themselves in palisades on each side, the orientation extending outwards for about ten rows or 40 μ before fading out. The tip of the needle by itself induced a radial arrangement, resembling an aster. Similar effects could be produced by fragments of glass, algal cells or other relatively large disturbance of the surface. When two such fragments were within about 80 μ, the appearance of the mitotic spindle was simulated. Tripolar effects could also be obtained.

The side spacing between the rods was commonly about 3 μ, compared with a cell width of about ½–1 μ and a length of 3 μ, but spacings of from one to five microns were sometimes observed with smaller and larger species. The cells were not in contact, for (1) electron micrographs showed no jelly, capsule, flagellæ or other material between them; (2) they could be pushed closer together by the micromanipulator and sprang apart when released; (3) if mobile rods of a smaller species were introduced, they swam up and down between the rows in straight lines without disturbing the structure, or being captured.

The aggregates appear to be the result of a long-range attraction and a shorter-range repulsion. Specificity is suggested by the occurrence side by side of many homogeneous aggregates of different species which separated out from a mixed suspension; and also by (3) above.

Surface tension forces probably account for some, but not all, of the interaction. Some of the effects (parallel orientation, spindles, asters) could be duplicated with human hair, chopped into 1-mm. lengths, floating on water, and by cardboard rods with alternate water-attracting and water-repelling bands, creating a pattern of attraction and repulsion which attracted a similar pattern but in general repelled a dissimilar pattern. But always the bodies came into contact, and surface tension cannot account for (1)

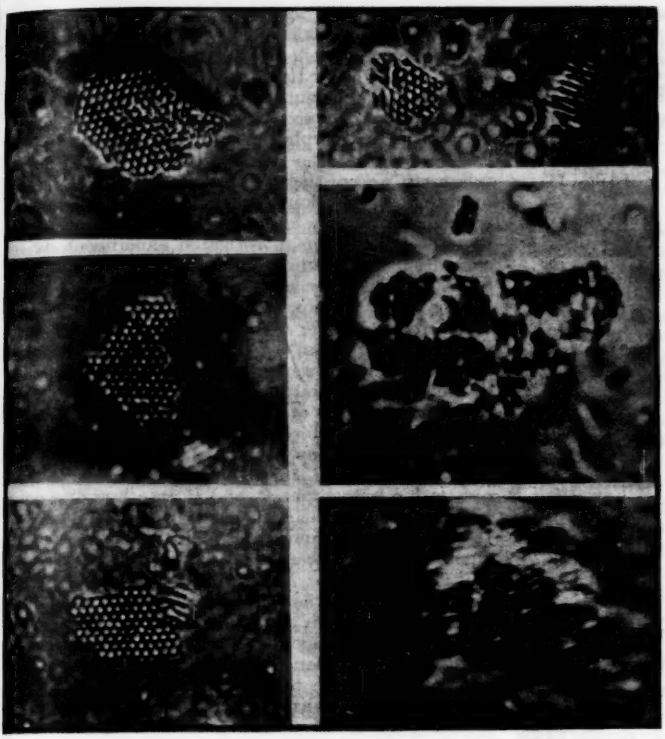

Fig. 1. Three-dimensional bacterial arrays. Left-hand side: end-on view. Right-hand side: side view

the lack of contact of the cells; (2) the fact that some species of bacilli did not orientate parallel (even when alongside others that did), especially if much salt was present (for example, *E. coli* in broth); (3) the occurrence of orientated aggregates in three dimensions, when any forces must act through the medium.

(*b*) *Three-dimensional aggregates.* Attempts to salt-out bacteria with ammonium sulphate (as used by Weibull[10] for bacterial flagellæ) resulted only in disorientated aggregates. Eventually regular three-dimensional aggregates were produced by accident during work on the effect of glycerol on amoebæ. Amoebæ and their associated food organisms were placed in serial dilutions of glycerol in Chalkley's medium in hanging drops, and set aside for a few days. In the range 1·5–3 per cent glycerol, the bacteria were found to have multiplied and in places built up, especially after 2–3 weeks, regular three-dimensional arrays, with the rods arranged parallel and in several layers (see Fig. 1).

All stages were visible, from aggregates of three and four through dozens to hundreds and thousands in dynamic equilibrium with the individual free-swimming ones in the solution. In the same field, the aggregates could be seen end-on (left-hand side of Fig. 1) showing the hexagonal packing of the rods; and sideways on, showing the rows of parallel palisades (right-hand side of Fig. 1); and half end-on, half sideways-on, showing both the ends and the sides of the rods. Focusing up and down showed that the depth of these aggregates was between 10 and 20 μ, corresponding to many layers of cells. The largest aggregate seen was 100 μ long, but it was somewhat twisted, showing that the forces are weak (that is, the crystal is soft). Each crystal had a shimmering or writhing movement, due to thermal agitation of its units or perhaps some residue of suppressed motility. For this reason and owing to the convexity of the sideways-on position, it was difficult to obtain good photographs. By focusing up and down in life the arrangement appears more clearly.

The appearance of the crystals is very similar to electron microscope pictures of virus crystals, for example, tobacco necrosis virus taken by Wyckoff[11], except that the spacing between the bacterial units is about a hundred times greater.

The question arises, should the bacterial arrays be called crystals? This question also arose in connexion with the crystallinity of virus arrays about fifteen years ago. Then Bernal and Fankuchen[8] stated that "crystallinity presupposes an indefinite repetition of identical units in three-dimensional space". The bacterial aggregates fulfil this condition, if one ignores the possible second-order differences within the individual cells. One might add a further stipulation, that the array should result from the mutual attraction of the units, so as to exclude such artificial arrays as pyramids of oranges.

The force required to hold the bacterial arrays together is quite small. A single polypeptide chain has a breaking strength of at least 10^{-4} mgm. weight (calculated from the tensile strength of silk, 30 tons/sq. in.). The weight of a bacterial cell (of volume 1 μ^3) is 10^{-9} mgm., so that a single molecular chain could support the weight of 100,000 bacterial cells, or, allowing for the buoyancy of water, one million bacterial cells. This shows how weak the force between the cells could be compared with a covalent bond.

When subcultures were made from the bacterial arrays in glucose broth, no crystals appeared; but on washing the bacteria and resuspending in 3 per cent glycerol, the crystals formed again. With insufficient washing, three-dimensional spindle-shaped aggregates, up to 100 μ long, containing thousands of approximately parallel cells, were formed on standing.

It is hoped to identify the coliform bacilli which form the arrays and to elucidate those factors in the medium which evoke the force involved. Further details will be published elsewhere.

It seems possible that the forces shown to operate between the bacterial cells may be concerned in various biological processes involving action at a distance of the order of a micron, such as between similar chromosomes at various stages of mitosis and meiosis[12]; between the submicroscopic rod-shaped particles of cellulose which Frey-Wyssling (1952) has shown orientate themselves parallel to one another at the surface of plant cells; between red cells in rouleaux formation; and between orientated fibrils in muscle cells which, when striated, align their bands.

I wish to thank Profs. A. Haddow and J. D. Bernal for their encouragement. This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [Aug. 11.

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EFFECT OF DEEP AND SHALLOW INCISIONS ON ORGANOGENESIS AT THE FERN APEX

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In earlier studies of the apex of *Dryopteris aristata* (*D. austriaca*), it has been shown that if the I_1 position (that is, that of the next leaf primordium to appear), or the last formed primordium, P_1, is isolated from the apical cell group by a deep tangential incision, so that the pre-vascular tissue is severed, a bud is formed; and if I_1, P_1, P_2 or P_3 are isolated from the adjacent older leaf primordia by deep radial incisions, they rapidly increase in size and outgrow older primordia[1,2]. A leaf primordium originates near the base of the apical cone by the enlargement of an elliptical group of superficial meristematic cells and the active division of the small underlying cells. The evidence thus far obtained supports the view that a leaf site is a well-defined locus of accumulation of substances which promote meristematic activity and growth, and that a primordium will be formed when external conditions are suitable and when the regulative effects of the apical cell-group and of the adjacent older primordia admit. The substances determining rapid growth in leaf sites may be accumulated from the adjacent superficial prism-shaped cells or from the underlying pre-vascular tissue.

The histological evidence is indicative of the movement of metabolites between the superficial cells of the apical meristem and the underlying pre-vascular layer. If the latter tissue affords a path for the rapid translocation of nutrients and growth-regulating substances in the apex, it will clearly have a particular importance in morphogenesis. The hypothesis was entertained that the regulative effect of the apical cell group, and of the two adjacent primordia, on the inception and development of a new leaf primordium is exercised by way of the pre-vascular tissue. This hypothesis has been investigated experimentally by comparing the effects on organ formation of various deep and shallow incisions as indicated in Figs. 1 and 2. In the deep incisions, the pre-vascular tissue was completely severed; in the shallow incisions, only the superficial prism-shaped cells were affected, the pre-vascular tissue remaining intact. The exactitude of the surgical operations was verified in appropriate microtome sections of apices.

The following information has been obtained:

(1) When a deep tangential incision is made on the adaxial side of I_1 (or of a young P_1, and sometimes also early-plastochrone P_2 and P_3[2]), a bud and not a leaf is formed; this bud grows rapidly, relative to the adjacent primordia. When the incision is shallow a leaf is formed.

(2) When I_1 (or P_1, P_2, etc.) is isolated by deep radial cuts from the adjacent older leaf primordia, a leaf primordium develops with an accelerated growth-rate and soon outgrows primordia several plastochrones older. With shallow radial cuts, accelerated growth has not been observed.

(3) Deep and shallow cuts abaxial to I_1, P_1, P_2, etc., are apparently not important from the point of view of organogenesis.

(4) When I_1 or P_1 (and sometimes P_2 and P_3) is isolated by four deep cuts, a bud and not a leaf is formed. When the four incisions are shallow, a normally-growing leaf primordium is formed. This latter result relates to the months of active apical growth. In apices which were operated upon during the earlier and later parts of the growing season, however, a very different result was obtained. When the I_1 position was isolated by shallow incisions no primordium appeared; and P_1 and P_2 similarly

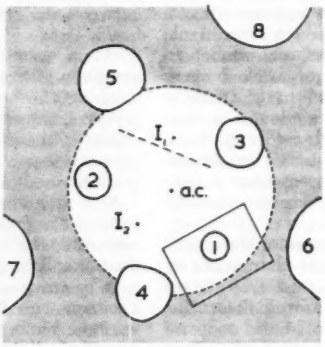

Fig. 1

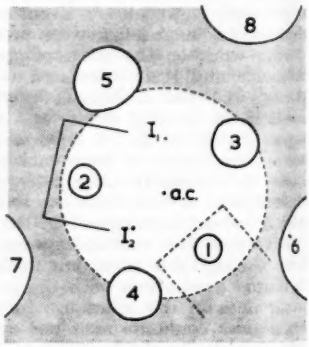

Fig. 2

Fig. 1. Apex of *Dryopteris* as seen from above (diagrammatic). The position of the next primordium to be formed, that is, I_1, has been isolated from the apex by a shallow tangential incision (broken line). Similar deep incisions were also made in other apices. The youngest visible primordium, that is, P_1, has been isolated by four deep incisions (continuous lines), similar shallow incisions being also made in other apices

Fig. 2. Primordium P_1 has been isolated by three shallow incisions, one adaxial, and P_2 by three deep incisions, one abaxial

treated not only failed to grow but gradually disappeared. Primordial growth was, however, usually obtained with a single shallow tangential cut (*see* (1) above).

(5) When early-plastochrone P_1, or P_2, is isolated by four shallow incisions, and the apical cell group of the main axis is punctured, a bud is usually formed.

The hypothesis under consideration, that is, that the regulative action of the apical cell group and adjacent leaf primordia takes place by way of the pre-vascular tissue, is supported by the results obtained. The severance of the pre-vascular tissue leads to important changes in the normal organogenic activity of the apex. Shallow incisions, by contrast, yield no comparable results.

The transformation of an organ of dorsiventral symmetry and ultimately limited growth into one of radial symmetry and potentially unlimited growth, by a simple surgical operation, is of course a remarkable phenomenon for which an explanation must be sought. The suggestion has already been made[1] that the characteristic symmetry and orientation of the leaf, with its limited adaxial growth and extensive tangential and abaxial growth, may be due to the position in which it originates, that is, on the side of the conical apex, together with inhibitional effects proceeding from the apical cell group. The present investigation has shed no new light on this problem; but further experiments directed to this end are in progress. It may here be noted, however, that a deep adaxial incision will not only preclude the basipetal movement of possible growth-inhibiting substances from the apical cell group: it will interfere radically with the whole system of metabolic gradients in the sector of the incision, the more so as a rapid and extensive wound-reaction is a conspicuous feature of injured meristems.

With shallow incisions there was (*a*) a marked wound-reaction and (*b*) the very curious and unexpected disappearance of young primordia at certain times of the year, and the failure of I_1 to appear. It may well be that the latter is directly related to the former, that is, that the rapid formation of wound tissue leads to a dispersal of the substances essential for leaf inception and growth. But since I_1, P_1 or P_2, isolated by deep cuts during the same period, do grow, it may be inferred that the isolated panel has enough of the substance(s) required for organ formation, provided the inhibitive or regulative effects of the apical cell-group and adjacent leaf primordia are eliminated.

The facts that nascent or very young leaf primordia may actually disappear when isolated by shallow incisions, that very young leaf primordia may be induced to develop as buds, and that both leaves and buds may be formed on the same apical meristem when the apical cell has been punctured[3], indicate that the normal fern meristem is a delicately regulated system and that the physiological changes induced in it by some surgical treatment are probably of a radical and far-reaching character.

The investigations briefly outlined here have been carried out in duplicate, that is, by each of the authors using considerable numbers of apices in each experiment and with close observations of each others specimens at critical stages. A fuller account of this work will be given elsewhere. [Sept. 2.

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QUALITATIVE ANALYSIS OF ORGANIC COMPOUNDS BY MASS SPECTROMETRY

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IT is well known that mass spectrometers are extensively used for quantitative analysis of mixtures of known components, but it is not so widely realized that they can also be used for qualitative analysis of unknown substances. The purpose of this communication is to direct attention to the potentialities of the mass spectrometer for this purpose and to describe developments which enhance its power. Like other analytical instruments, the mass spectrometer can be used more easily for identifying a pure substance than a mixture; but it has the advantage that it is usually possible from the mass spectrum of an unknown material to determine whether or not it is a mixture. Since the mass spectrometer can handle milligram quantities of material boiling below about 400° C., vapour phase chromatography offers an ideal method for the separation of mixtures into their component parts prior to analysis.

Qualitative analysis by examination of the mass: charge ratios and relative abundances of the various positive ion species formed when a vapour is bombarded with electrons of about 50 eV. energy is based on empirical relationships derived from examination of large numbers of mass spectra; for example, those collected together by the American Petroleum Institute[1]. Terminal groups can often be identified by characteristic peaks; for example, a large peak at mass : charge ratio 30 is strong evidence in favour of an amine or imine. Information as to the general structure of the molecule is also easily obtained. For example, a large 'parent' peak (corresponding to ionization of the whole molecule without fragmentation) indicates a strong structure such as a ring, and the relative abundances of fragment ions usually enable one to decide whether the ring is resonance-stabilized or not. Alkyl side-chains on an aromatic ring tend to break under electron bombardment at the bond next but one to the ring, giving a positive ion containing the ring, whereas a saturated ring tends to break at the bond joining the alkyl group to the ring. Many similar empirical rules can readily be deduced from published mass spectra.

From an analytical point of view, the molecular weight is perhaps the most useful single item of information obtainable by mass spectrometry, and this is determined by mass measurement of the parent peak. If the substance is known to be a hydrocarbon, the molecular weight leads directly to the empirical formula or, in the case of high molecular weights, to a small number of possible empirical formulæ. Thus a molecular weight of 106 gives an empirical formula of C_8H_{10}, and with the aid of rules of breakdown based on comparison spectra it is a simple matter to limit the molecular formula to a small number of possibilities, which can be investigated separately by the use of reference samples, or known chemical or physical properties. If, however, the material is not known to be a hydrocarbon, a much larger number of possible empirical formulæ

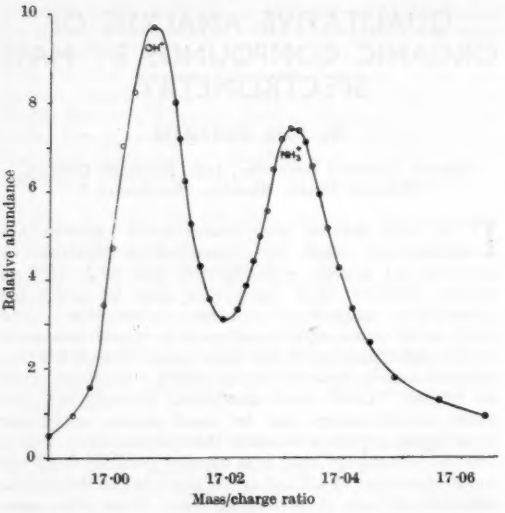


Fig. 1

correspond to a given molecular weight, and often the only useful information to be derived from the molecular weight concerns the number of nitrogen atoms, since all organic compounds of carbon, hydrogen, nitrogen, oxygen, sulphur, phosphorus and the halogens having an odd molecular weight must contain an odd number of nitrogen atoms. Since chlorine and bromine have very abundant isotopes, which are two mass numbers heavier than the main isotopes, the number of chlorine and bromine atoms present in an unknown molecule can usually be determined immediately from the strengths of the isotopic peaks. Numerous atomic arrangements can also be written for all but the lightest fragment ions in the mass spectra of non-hydrocarbon compounds and more than one type of ion may contribute to give a multiple but unresolved mass peak. To overcome the consequent difficulties in interpretation of such mass spectra the technique of accurate mass measurement has been devised.

The principle of this technique is to make use of the fact that atomic masses are not exactly integral multiples of a unit mass. Thus $^{12}CH_2^+$ and $^{14}N^+$, both nominally of mass 14, actually have masses of 14·0196 and 14·0070 A.M.U. respectively[2], and so on for more complicated combinations of atoms. It follows that if the mass of any ion is measured with sufficient precision, its elemental composition can immediately be deduced, and the mass spectrum of an unknown substance then gives not only the empirical formula, but also a great deal of information about the arrangement of the atoms within the molecule.

In order to apply the method to multiple mass peaks, a mass spectrometer of high resolving power is necessary, and such an instrument, with a resolving power of 2,500, is being built for this work in these laboratories by Metropolitan-Vickers, Ltd. However, it has been found possible to use an existing Nier type mass spectrometer[3] (90° sector type), with a resolving power of about 250, to prove the validity of the method by narrowing the exit slit. The resolving power attainable is shown in Fig. 1, and although peak heights then no longer give an accurate measure of the abundance of any ion species, this is of no importance during the mass measurements. For reference purposes, a mass spectrum is always plotted with the exit slit opened to its normal width before accurate mass measurements are commenced.

The mass measurements are made by scanning from the unknown mass peak to a reference mass peak of known mass by variation of the accelerating voltage at constant magnetic field. A constant fraction of the accelerating voltage corresponding to each mass is read on a Diesselhorst thermo-electric free potentiometer accurate to 1 part in 10^5. Then $m_1/m_2 = V_2/V_1$. Reference samples giving mass peaks of known composition as close as possible to the unknown mass peak or group of peaks are introduced through a separate sample-handling system to serve as mass standards. Several such samples are necessary for mass measurements on a complete mass spectrum. The principal inaccuracies in the measurements arise from three causes. These are errors due to: (1) neglect of the kinetic energy possessed by the ions on formation; (2) variation of either the magnetic field or accelerating voltage during the measurements; and (3) difficulty in setting on the exact summits of the peaks. The first and only systematic error will be eliminated by the use of double focusing in the new instrument, while the second and third inaccuracies will be very much reduced by more stable circuits and sharper-topped peaks. For the present, the first error is kept as small as possible by working at the highest possible accelerating potential (2,000 volts), and none of the mass peaks so far measured has proved to be in error by more than 1 part in 7,000. Measurements on parent peaks (from parent reference peaks) give results at least three times as accurate as this.

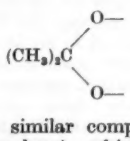
To illustrate the value of the method in deducing the molecular structure from the mass spectrum, accurate mass measurements have been made on the most abundant ionic species in the mass spectrum of α-pyrrolidone. The mass of the parent peak was measured from the parent peak of cyclohexene (82·1040) introduced as a reference, which gave a value of 85·0794. Consideration of the various combinations of carbon, hydrogen, nitrogen and oxygen which can give a nominal molecular weight of 85 then leads directly to the empirical formula. Thus, some of the possibilities are: $C_6H_{11}N^+ = 85{\cdot}1159$; $C_4H_7NO^+ = 85{\cdot}0794$; $C_3H_3NO_2^+ = 85{\cdot}0430$; $C_5H_7N_2^+ = 85{\cdot}0907$; $C_3H_3N_2O^+ = 85{\cdot}0543$. Combinations containing an even number of nitrogen atoms are not included, on account of the odd numbered molecular weight, though their inclusion would lead to no confusion. Lower mass peaks in the spectrum were measured, with the results given in the table.

The fact that the parent peak is the strongest in the spectrum indicates a ring structure; the occurrence of CNO^+ ions but not of NO^+ ions suggests the presence of a $-N-\overset{\overset{O}{\parallel}}{C}-$ group, and the ions $C_3H_4N^+$ and $C_3H_6^+$ show three adjacent $-CH_2-$ groups. The structure follows immediately.

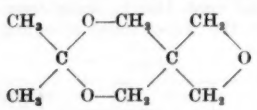
A further advantage of mass measurement appears when the peak of highest mass in the mass spectrum is very weak compared with the next highest peak and, therefore, is easily overlooked. Again, if the strong peak corresponds to an uneven mass, without accurate mass measurement it would be deduced that the compound responsible for it contained an

Reference peak	Nominal mass	Measured masses	Identification
$C_3H_5O^+$ from acetone	56 (triple peak)	56·0323	$C_3H_5NO^+$ = 56·0310
		56·0446	$C_3H_6O^+$ = 56·0436
		56·0670	$C_4H_8N^+$ = 56·0674
$C_2H_3O^+$ from acetone	42 (quadruple peak)	42·0102	CNO^+ = 42·0109
		42·0287	$C_2H_2O^+$ = 42·0235
		42·0538	$C_2H_4N^+$ = 42·0473
		42·0592	$C_3H_6^+$ = 42·0599
C_2HO^+ from acetone	41 (triple peak)	41·0174	C_2HO^+ = 41·0153
		41·0443	$C_2H_3N^+$ = 41·0392
		41·0503	$C_3H_5^+$ = 41·0518
O_2^+ from air	30 (triple peak)	30·0169	CH_2O^+ = 30·0196
		30·0438	CH_4N^+ = 30·0435
		30·0533	$C_2H_6^+$ = 30·0561
CH_4N^+ from unknown	28 (triple peak)	28·0117	$CO^+ + N_2^+$ (from air) unresolved
		28·0268	CH_2N^+ = 28·0272
		28·0365	$C_2H_4^+$ = 28·0398
CH_3N^+ from unknown	27 (double peak)	27·0184	CHN^+ = 27·0190
		27·0322	$C_2H_3^+$ = 27·0316

odd number of nitrogen atoms. An example of this is provided by the mass spectrum of 6 : 6-dimethyl-1 : 5 : 7-trioxa-3 : 5-spirononane (I), which was selected as a test of the method. The first strong peak (143) is more than 3,000 times stronger than the parent peak (158), which might easily have been attributed to an impurity. Careful mass measurements on this and other strong mass peaks proved that the compound contained no nitrogen, but three atoms of oxygen. The empirical formula for ions of mass 143 was $C_7H_{11}O_3^+$ and the formula for the complete molecule was assumed to be $C_8H_{14}O_3$, since a prominent peak at mass 15 proved to be CH_3^+. Other peaks at 113 and 86 respectively proved to be $C_6H_9O_2^+$ and $C_5H_{10}O^+$ and clearly represent entirely different modes of fracture of the molecule. Assuming the molecule to be of the form $X + Y + Z$, the two peaks being $X + Y$ and $Y + Z$ respectively, we have $X = C_3H_4O_2$, $Y = C_2H_6$, $Z = C_3H_8O$ giving the dispositions of the carbons and oxygens. Too much reliance is not placed on the hydrogens due to the ease with which they take part in re-arrangements on ionization. A very strong peak at 41 ($C_3H_5^+$) could not have come from the centre of the molecule, so that the molecule is probably ($C_2H_?$) (O_2) ($C_2H_?$) (C_2H_7O). A knowledge of the chemistry involved, together with an infra-red spectrum, would usually enable the final step to the complete structure to be taken, while the empirical rules of breakdown referred to at the beginning of this communication suggest the group :

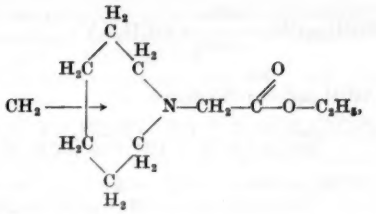


by analogy with similar compounds (for example, 2-methyl-1 : 3-dioxalane) which give very weak parent peaks. In this case the formula is :

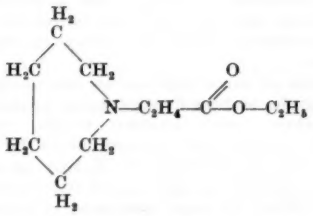


(I)

The compound of unknown constitution of highest molecular weight so far examined by this method was of molecular weight 199. Its structure was deduced by accurate mass measurements alone to be :



the arrow indicating that the position of the CH_2 group on the ring is uncertain. The actual structure was :



Our experience during the past three months has shown the above technique, either alone or in conjunction with infra-red spectroscopy, to be of wide application in the identification of small quantities of unknown organic compounds.

[1] American Petroleum Institute Research Project 44, "Catalog of Mass Spectral Data", National Bureau of Standards, Washington, D.C.
[2] Ogata, K., and Matsuda, H., *Phys. Rev.*, **89**, 27 (1953).
[3] Graham, R. L., Harkness, A. L., and Thode, H. G., *J. Sci. Instr.*, **24**, 119 (1947).

TOXIC FLUORINE COMPOUNDS

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In an earlier report[1] we have described the preparation and toxicities of several series of aliphatic compounds containing an ω-fluorine atom; these included ω-fluorocarboxylates, ω-fluoroalcohols, ω-fluoroaldehydes, ω-fluoronitriles, ω-fluoroamines and ω-fluoro-ω′-nitroalkanes. An attempt was made to correlate the toxicities with known metabolic mechanisms; in general, it was apparent that those compounds which could give rise *in vivo* to an ω-fluorocarboxylic acid containing an even number of carbon atoms were toxic, whereas all others were innocuous. The present communication gives a further account of the preparation and toxicity of allied compounds. Standard comparison figures and procedures for testing are the same as those described in the earlier report. To avoid ambiguity, fluorine is not generally referred to as a halogen throughout this report.

ω-Fluoroalkyl halides, $F(CH_2)_nX$. Several of the lower members of this series (n = 2–5) have already been described[2–4]; of the preparations reported, the most satisfactory general method involves the partial fluorination of ω,ω′-dihalogenoalkanes using potassium fluoride in diethylene glycol[2].

We have obtained ω-fluoroalkyl halides by the following general routes :

(1) $F(CH_2)_nOH \xrightarrow[\text{or } SOCl_2]{PBr_3} F(CH_2)_nX$;

(2) $X(CH_2)_nX \xrightarrow{KF} F(CH_2)_nX$;

(3) $F(CH_2)_nO.SO_2R + KX \rightarrow F(CH_2)_nX + KO.SO_2R$ ($R = CH_3^-$ or p-$CH_3.C_6H_4^-$) ;

(4) $X(CH_2)_nO.SO_2R + KF \rightarrow X(CH_2)_nF + KO.SO_2R$ ($R = CH_3^-$ or p-$CH_3.C_6H_4^-$).

ω-Fluoroalkyl iodides are most readily prepared by method (3), or by treatment of the corresponding ω-fluoroalkyl chlorides with potassium iodide in acetone ; methods (1) and (2) are most convenient for preparing the chlorides and bromides. A fifth general method is mentioned below, under 'anodic syntheses'.

The value of these derivatives lies in the greater stability of the carbon–fluorine bond relative to that of the other carbon–halogen bonds, making it possible to replace the halogen atom by standard reactions without affecting the fluorine atom. They have thus become valuable synthetic intermediates, and from them we have prepared ω-fluoroalkynes, ω-fluoroethers, ω-fluoronitriles, ω-fluoro-ω′-nitroalkanes, ω-fluorothiocyanates and other miscellaneous ω-fluorocompounds. Further reference to their importance in synthetic work will be made below, in connexion with Grignard reactions.

Very few references to the pharmacology of aliphatic monohalogen compounds are available. Ethyl chloride apparently does not form ethyl alcohol when used as a general anæsthetic, and ethyl iodide is very largely recovered unchanged in the urine and respiratory gases when used for testing circulatory rates[5]. If one applies these observations to the 2-fluoroethyl halides, it follows that they would not give rise to fluoroethanol and hence would not be toxic ; this conclusion has already been confirmed by previous workers[2] in the case of 2-fluoroethyl chloride and 2-fluoroethyl bromide. In spite of this, we thought that certain representative higher members should be examined because of their more labile halogen, and hence more ready conversion to the corresponding fluoroalcohol. Some results are shown in Table 1.

Table 1

Compound	Formula	L.D. 50 for mice (mgm./kgm.)
2-Fluoroethyl iodide	$F(CH_2)_2I$	28
3-Fluoropropyl bromide	$F(CH_2)_3Br$	> 100
4-Fluorobutyl chloride	$F(CH_2)_4Cl$	1·25
4-Fluorobutyl bromide	$F(CH_2)_4Br$	8·2
4-Fluorobutyl iodide	$F(CH_2)_4I$	5·2
5-Fluoroamyl chloride	$F(CH_2)_5Cl$	32
6-Fluorohexyl chloride	$F(CH_2)_6Cl$	5·8
6-Fluorohexyl bromide	$F(CH_2)_6Br$	12·8
7-Fluoroheptyl chloride	$F(CH_2)_7Cl$	> 100
8-Fluorooctyl chloride	$F(CH_2)_8Cl$	2·3
8-Fluorooctyl bromide	$F(CH_2)_8Br$	20
9-Fluorononyl chloride	$F(CH_2)_9Cl$	> 100
10-Fluorodecyl chloride	$F(CH_2)_{10}Cl$	5·0
11-Fluoroundecyl bromide	$F(CH_2)_{11}Br$	> 100
12-Fluorododecyl bromide	$F(CH_2)_{12}Br$	16

From these figures, it is apparent that the even members are of the same order of toxicity as the corresponding members of the original ω-fluorocarboxylate series. This in turn is good evidence of the ready loss of the halogen in all but the lowest members of the series.

Because of the resistance of the carbon–fluorine bond to hydrolysis, it was expected that the *ω,ω′-difluoroalkanes*, $F(CH_2)_nF$, would be excreted unchanged. Three members were submitted for routine testing and, surprisingly, were found to be moderately toxic. No alternation was apparent on the basis of the L.D. 50 figures : 1,4-difluorobutane ($n = 4$), 19·5 mgm./kgm. ; 1,5-difluoropentane ($n = 5$), 12 mgm./kgm. ; and 1,18-difluorooctadecane ($n = 18$), 10 mgm./kgm.

ω-Fluoroalkenes $F(CH_2)_nCH=CH_2$, *and ω-Fluoroalkynes*, $F(CH_2)_nC\equiv CH$. *ω-Fluoroalkenes* have not been studied extensively hitherto ; the only member that we have prepared so far[1] is 11-fluoro-undec-1-ene, $F(CH_2)_9CH=CH_2$, which has an L.D. 50 of 9·3 mgm./kgm. It is thus considerably more toxic than 11-fluoroundecanol, 11-fluoroundecyl bromide or ethyl 11-fluoroundecanoate, all of which have an L.D. 50 greater than 100 mgm./kgm., but less toxic than 11-fluoro-1,2-dihydroxyundecane, $F(CH_2)_9CH(OH).CH_2OH$ (L.D. 50, 1·75 mgm./kgm.). It is suggested that some hydroxylation of the double bond occurs *in vivo* giving the dihydroxy-derivative, which is afterwards converted to the toxic 10-fluorodecanal :

$$F(CH_2)_9CH=CH_2 \rightarrow F(CH_2)_9CH(OH).CH_2OH \rightarrow F(CH_2)_9CHO.$$

ω-Fluoroalkynes can readily be prepared from ω-fluoroalkyl halides by reaction with sodium acetylide in liquid ammonia[6] or from the corresponding ω-chloroalkynes by fluorination with potassium fluoride :

$$F(CH_2)_nX + NaC\equiv CH \rightarrow F(CH_2)_nC\equiv CH + NaX$$
$$Cl(CH_2)_nC\equiv CH + KF \rightarrow F(CH_2)_nC\equiv CH + KCl.$$

They form solid metallic derivatives, for example, *bis*-6-fluorohex-1-ynyl mercury, $F(CH_2)_4C\equiv C.Hg.C\equiv C(CH_2)_4F$; but so far we have been unsuccessful in replacing the acetylenic hydrogen with organic groupings. Because the extreme electronegativity of fluorine leads to a highly polar carbon–fluorine bond, the ω-fluoroalkynes tend to lose fluorine in the presence of reagents such as sodamide and Grignard reagents, rather than undergo the reactions characteristic of the non-fluorinated alkynes. Thus, the reaction of 6-fluorohex-1-yne with sodamide produced an indeterminate mixture of products, and with ethyl magnesium bromide followed by carbon dioxide produced fluorine-free polymers.

It can be seen from Table 2 that the ω-fluorine atom confers toxic properties on the acetylenes.

ω-Fluoroalkyl thiocyanates, $F(CH_2)_nSCN$. These compounds were prepared in an attempt to combine the toxic action of the thiocyanate grouping with that of the ω-fluoroalkyl grouping. Two lower members had already been prepared, namely, 2-fluoroethyl thiocyanate[2], $F(CH_2)_2SCN$, and 3-fluoropropyl thiocyanate[7], $F(CH_2)_3SCN$. Since the toxicities of these two members differed only slightly, it was considered likely that the toxicity was associated exclusively with the thiocyanate grouping. To con-

Table 2

Compound	Formula	L.D. 50 for mice (mgm./kgm.)
Hex-1-yne	$CH_3(CH_2)_3C\equiv CH$	> 400
6-Fluorohex-1-yne	$F(CH_2)_4C\equiv CH$	15
7-Fluorohept-1-yne	$F(CH_2)_5C\equiv CH$	20
8-Fluorooct-1-yne	$F(CH_2)_6C\equiv CH$	7·5
9-Fluorononyl-1-yne	$F(CH_2)_7C\equiv CH$	79

Table 3

Compound	Formula	L.D. 50 for mice (mgm./kgm.)
n-Amyl thiocyanate	$CH_3(CH_2)_4SCN$	75
2-Fluoroethyl thiocyanate	$F(CH_2)_2SCN$	15
3-Fluoropropyl thiocyanate	$F(CH_2)_3SCN$	18
4-Fluorobutyl thiocyanate	$F(CH_2)_4SCN$	2·6
5-Fluoroamyl thiocyanate	$F(CH_2)_5SCN$	30
6-Fluorohexyl thiocyanate	$F(CH_2)_6SCN$	5·0

firm this, three adjacent higher members, together with a non-fluorinated member, were prepared[8] from the corresponding halogen compounds by reaction with potassium thiocyanate. Results are shown in Table 3.

It can be seen that, contrary to expectation, the fluorine is essential for high toxicity, and that the even-membered derivatives are again the more toxic. It seemed possible that the thiocyanates were being reduced *in vivo* to hydrogen cyanide and the corresponding mercaptan:

$$F(CH_2)_nSCN + 2H \xrightarrow{\text{hydrogenase}} F(CH_2)_nSH + HCN.$$

This line of reasoning led us to investigate the ω-fluoroalkyl mercaptans, the high toxicity of which added weight to the suggestion.

ω-Fluoroalkyl mercaptans, $F(CH_2)_nSH$. As mentioned in the preceding section, mercaptans were prepared for comparison with the thiocyanates; they are also of interest as the sulphur analogues of the ω-fluoroalcohols. In the initial experiments, the preparation of the ω-fluoroalkyl mercaptans proved to be difficult. The standard reactions, such as interaction of the corresponding bromide with thiourea followed by hydrolysis, gave very low yields. Moreover, the members containing four, five and six carbon atoms tended to cyclize very readily, forming tetrahydrothiophene, tetrahydrothiopyran and hexamethylene sulphide, respectively. From a consideration of the behaviour of the thiocyanates, we decided to simulate the suggested biological reduction by treatment with lithium aluminium hydride. The ω-fluoroalkyl mercaptans were thus obtained[8–10] in 80 per cent yield. The only exception was 4-fluorobutyl mercaptan, which still cyclized to tetrahydrothiophene; accordingly, its acetate, 4-fluorobutyl thiolacetate, was synthesized[10] directly by the following steps:

$$F(CH_2)_4I + AgO.SO_2C_6H_4.CH_3 \rightarrow F(CH_2)_4O.SO_2C_6H_4.CH_3;$$

$$F(CH_2)_4O.SO_2C_6H_4.CH_3 + KSAc \rightarrow F(CH_2)_4SAc + KO.SO_2C_6H_4.CH_3.$$

We had previously shown this method to be satisfactory for the preparation of 2-fluoroethyl thiolacetate.

As can be seen from Table 4, a pronounced alternation is again apparent, with toxicities comparable to those of the ω-fluoroalcohol series. It is possible that those mercaptans with an even number of carbon atoms are toxic due to biological conversion to the corresponding ω-fluoroalcohols by transthiolation [$F(CH_2)_nSH \rightarrow F(CH_2)_nOH$].

Table 4

Compound	Formula	L.D. 50 for mice (mgm./kgm.)
n-Amyl mercaptan	$CH_3(CH_2)_4SH$	>100
2-Fluoroethyl thiolacetate	$F(CH_2)_2SAc$	56
3-Fluoropropyl mercaptan	$F(CH_2)_3SH$	>100
4-Fluorobutyl thiolacetate	$F(CH_2)_4SAc$	1·8
5-Fluoroamyl mercaptan	$F(CH_2)_5SH$	>100
6-Fluorohexyl mercaptan	$F(CH_2)_6SH$	1·25

ω-Fluoroalkanesulphonyl chlorides and fluorides, $F(CH_2)_nSO_2X$. The ω-fluoroalkanesulphonic acids, $F(CH_2)_nSO_3H$, are the sulphonic acid analogues of the ω-fluorocarboxylate series, $F(CH_2)_nCOOH$, and the two classes thus bear a superficial resemblance to one another. In order to compare the effects of the two classes, representative derivatives of the former were prepared and tested. It has been reported that *n*-alkanesulphonic acids are non-toxic[11] and are excreted unchanged by the dog[12]; hence no great activity was anticipated for the ω-fluoro-derivatives. Two members of the sulphonyl chloride series had been prepared previously, 2-fluoroethanesulphonyl chloride[3], $F(CH_2)_2SO_2Cl$, and 3-fluoropropanesulphonyl chloride[7], $F(CH_2)_3SO_2Cl$; but toxicity determinations on these derivatives were indefinite. We prepared[10,13] the members listed in Table 5 by two general routes:

$$(1)\ F(CH_2)_nX \xrightarrow{KCNS} F(CH_2)_nSCN \xrightarrow{Cl_2,\ aq.} F(CH_2)_nSO_2Cl \xrightarrow{KFHF} F(CH_2)_nSO_2F;$$

$$(2)\ F(CH_2)_nOH \xrightarrow{TsCl} F(CH_2)_nOTs + S{=}C(NH_2)_2 \rightarrow [F(CH_2)_nS.C(NH_2)=NH_2]^+{}^-OTs \quad (Ts = p\text{-}CH_3.C_6H_4SO_2\text{—})$$
$$\xrightarrow{Cl_2,\ aq.} F(CH_2)_nSO_2Cl \xrightarrow{KFHF} F(CH_2)_nSO_2F.$$

From an examination of the toxicity results so far available, it can be seen that the sulphonyl chlorides exhibit a definite alternation in toxicity. This suggests that β-oxidation of the sulphonyl chlorides may occur, a point which is being investigated further by the preparation and study of related compounds. On the other hand, little or no correlation between structure and toxicity is apparent in the case of the sulphonyl fluorides; such activity as they possess may be connected with cholinesterase inhibition[14].

Table 5

Value of *n* in $F(CH_2)_nSO_2X$	L.D. 50 for mice (mgm./kgm.)	
	$X = Cl$	$X = F$
2	< 10	—
3	64	84
4	18	10
5	> 100	88
6	9	45
$CH_3(CH_2)_5SO_2X$	> 100	70

Miscellaneous ω-fluoro sulphur compounds. Methyl and ethyl fluorothiolacetate, $FCH_2CO.SR$ ($R = CH_3$— and C_2H_5—), were prepared for enzyme studies. Both had a toxicity very similar to that of methyl fluoroacetate. This is readily explained by hydrolysis *in vivo* to the toxic fluoroacetate ion.

ω-Fluoroalkyl methanesulphonates, benzenesulphonates and *p*-toluenesulphonates were prepared as intermediates for other syntheses. Three general methods of preparation were used:

(1) $F(CH_2)_nOH + ClSO_2R \rightarrow F(CH_2)_nO.SO_2R + HCl$ ($R = CH_3$—, C_6H_5—, p-$CH_3.C_6H_4$—)

(2) $F(CH_2)_nOH + FSO_2R \rightarrow F(CH_2)_nO.SO_2R + HF$ ($R = CH_3$—, p-$CH_3.C_6H_4$—);

(3) $F(CH_2)_nX + AgO.SO_2R \rightarrow F(CH_2)_nO.SO_2R + AgX$ ($R = CH_3$—, p-$CH_3.C_6H_4$—).

It is of interest that both 2-fluoroethyl and 3-fluoropropyl methanesulphonate were non-toxic (L.D. 50, > 100 mgm./kgm.); since the two parent fluoroalcohols show a marked difference of toxicity, the conclusion may be drawn that at least the 2-fluoroethyl derivative is not readily hydrolysed *in vivo*. On the other hand, the fact that 4-fluorobutyl methanesulphonate had an L.D. 50 of 1 mgm./kgm. suggests that hydrolysis of this member is occurring, giving rise to the toxic 4-fluorobutanol.

Compounds of Biological Interest

Two *fluorinated barbiturates*, 5-ethyl-5-(4′-fluorobutyl)-barbituric acid (fluoroneonal) and 5-ethyl-5-(5′-fluoroamyl)-barbituric acid, have been prepared[10] for comparison with the non-fluorinated materials. Their synthesis was carried out as follows:

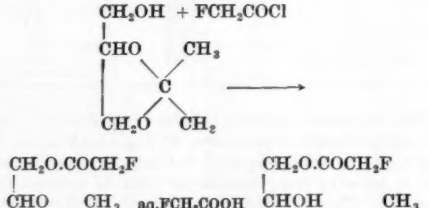
$$F(CH_2)_nX + NaCEt.(COOEt)_2 \rightarrow F(CH_2)_nCEt.(COOEt)_2$$

$$\xrightarrow{\text{urea}} \quad \begin{matrix} F(CH_2)_n & CO{-}NH \\ & \diagdown\ C\ \diagup \\ C_2H_5 & CO{-}NH \end{matrix} \quad \begin{matrix} \diagup \\ CO \\ \diagdown \end{matrix}$$

($n = 4$ and 5; X = Br or I).

Their activity as central nervous depressants was considerably less than that of their non-fluorinated analogues and their toxicity was relatively low. These conclusions have been confirmed recently by Bruce and Huber[15], who prepared various 5-(3′-fluoropropyl)- and 5-(5′-fluoroamyl)-barbituric acids; they concluded that the products were less effective than the non-fluorinated analogues. The intermediate fluoro-esters obtained in our syntheses were non-toxic.

Chenoweth has reported[16] that glyceryl 1-monoacetate (monoacetin) is effective in offsetting the symptoms of fluoroacetate poisoning. If a reason for this therapy is the liberation of a particularly active 'C_2 fragment' for competition with fluoroacetate, then it follows that *glyceryl 1-monofluoroacetate* (fluoromonoacetin) might give rise to a particularly active 'fluoro-C_2 fragment', with resultant enhancement of toxicity or speed of action. This was prepared by an unequivocal route, and was found to be neither more toxic (L.D. 50 for mice, 12 mgm./kgm.) nor faster acting than methyl fluoroacetate.



Glyceryl tris-monofluoroacetate (fluorotriacetin), prepared for comparison with fluoromonoacetin, was found to be rather more toxic (L.D. 50 for mice, 6·7 mgm./kgm.) but otherwise did not differ in its effects.

For comparison with oxalacetic acid, *diethyl fluorooxalacetate*, $C_2H_5OOC.CHF.CO.COOC_2H_5$, was prepared[10] by a Claisen condensation of ethyl fluoroacetate and diethyl oxalate; it was found to be non-toxic (L.D. 50, > 400 mgm./kgm.).

Fluorinated esters and ethers are being screened for insecticidal properties. The following compounds have already been tested: fluoroethyl valerate, caproate, caprylate, pelargonate, caprate, laurate, tridecanoate, myristate, palmitate, stearate, oleate and benzoate; octyl, decyl, undecyl, dodecyl, tetradecyl, hexadecyl, octadecyl, undecylenyl and phenyl fluoroacetates; methyl 5-fluoroamyl ether, methyl 6-fluorohexyl ether, 1,2,2,2-tetrachloroethyl 2′-fluoroethyl ether and 2-fluoroethyl 2′-butoxyethyl ether.

Work is proceeding on the synthesis of fluorinated analogues of other drugs and metabolites; these are being examined for activity in the treatment of specific diseases. Other compounds are being prepared in which the fluorine will be used as a 'tag' in biochemical and pharmacological studies. Full details of these phases of this work will be reported at a later date.

Preparation of Monofluoro Compounds

A survey of the literature has shown that general methods of preparation of monofluorinated organic compounds have never been the object of an extensive investigation. This problem is now under review with special emphasis on metal fluorides, solvents, type of halogen, temperature and other reaction conditions.

At the present time the introduction of the fluorine atom is most readily carried out by the reaction of potassium fluoride with the corresponding halogen compound. The technique for this reaction is dependent on the stability and on the quantity of the material to be fluorinated. In general, the most satisfactory method involves heating with excess potassium fluoride in ethylene glycol or diethylene glycol with vigorous stirring[3,17,18]; acetamide has recently been reported as an alternative solvent for the reaction[19]. The product can be continuously distilled from the reaction mixture, or the heating may be carried out under reflux with subsequent isolation of the product. By modifications of temperature and concentrations, yields of 40–70 per cent are obtained. If the product or reactants are unstable in hydroxylic solvents, the reaction may be carried out in a stainless steel autoclave under anhydrous conditions using vigorous stirring and no solvent; however, only a limited number of compounds can be fluorinated satisfactorily by this method, and the large volume of our reaction bomb makes it useless for small-scale exploratory runs, particularly those involving expensive or rare intermediates.

When halogen exchange was not practicable, we have prepared[10] monofluoro compounds from alkyl sulphonates by treatment with potassium fluoride according to methods of earlier workers[4,20]. The alkyl sulphonates were originally prepared from the corresponding alcohols by reaction with sulphonyl chlorides in the presence of pyridine or sodium hydroxide:

$$R.OH + ClSO_2R' \rightarrow RO.SO_2R' + HCl;$$

$$RO.SO_2R' + KF \rightarrow RF + KO.SO_2R'$$

(R', aliphatic or aromatic).

For satisfactory yields in the potassium fluoride cleavage, it is advantageous to exclude all traces of sulphonyl chlorides and ionic chloride. Consequently, we developed a modified preparation of the alkyl sulphonates to avoid these impurities: this involves

treatment of an alcohol with a sulphonyl fluoride, in the presence of excess anhydrous potassium fluoride to remove the resultant hydrogen fluoride as potassium bifluoride. Excellent yields (90–95 per cent) of alkyl sulphonates were thus obtained. The advantages of carrying out the sulphonation and fluorination as a one-step process are being investigated.

We have made use of anhydrous hydrogen fluoride to a limited extent in a variety of reactions such as addition to unsaturated compounds and opening of cyclic ethers. In certain specific reactions, different metal fluorides have been employed; of these, silver fluoride is particularly useful for small-scale trial fluorinations of relatively stable halogen compounds. Zinc fluoride is convenient for forming acyl fluorides. The use of potassium bifluoride for forming sulphonyl fluorides has been mentioned earlier in this article.

The carbon–fluorine bond is stable to most reagents. Thus the functional groups of ω-fluoro compounds undergo a wide variety of reactions, such as replacements, oxidations and reductions, without simultaneous loss of fluorine. Many of these have been mentioned throughout these reports, but two general synthetic routes are worthy of comment here:

(*a*) *Grignard reactions.* The potentialities of ω-fluoroalkyl Grignard reagents, $F(CH_2)_nMgX$, are great, since they offer a simple and direct route to a large number of complex and otherwise inaccessible ω-fluoro compounds. Hoffmann[3] reported that although the ω-fluoroalkyl bromides appeared to react normally with magnesium and dry ether, the only products obtained were devoid of fluorine. Accordingly, it was postulated that transitory formation of the Grignard reagent resulted in preferential loss of magnesium fluoride. More recently, we reported[9] preliminary experiments using 11-fluoroundecyl bromide in which normal Grignard formation and reactions appeared to occur. We have now re-examined this problem, and have proved that, by very careful control of the initiation of Grignard formation and of conditions for subsequent replacements, the normal reactions can be made to take place[10]; for example:

$$F(CH_2)_6X \rightarrow F(CH_2)_6MgX \xrightarrow[-80^\circ\ C.]{CO_2} F(CH_2)_6CO.OMgX \xrightarrow{hydr.} F(CH_2)_6COOH \text{ (64 per cent overall yield).}$$

A systematic study is being undertaken to determine the effect of different chain-lengths, of different halogens, of different metals, of variations in conditions and of different types of Grignard reactions.

(*b*) *Anodic syntheses.* Except for one very recent reference[11], no mention appears in the literature of the Kolbe electrolytic coupling with any type of halogen-containing acid, other than halogenated acetic acids. As a preliminary study, we have developed[10] a route to ω,ω′-dihalides from ω-halogeno-acids (*c.* 50 per cent yield). Thus 3-chloropropionic acid forms 1,4-dichlorobutane and 5-chlorovaleric acid forms 1,8-dichlorooctane:

$$2\ Cl(CH_2)_nCOOH \rightarrow Cl(CH_2)_{2n}Cl + 2\ CO_2 + H_2.$$

The dihalides on partial fluorination yield the corresponding ω-fluoroalkyl halides.

ω-Fluoroacids undergo this same type of reaction; for example, 10-fluorodecanoic acid forms 1,18-difluorooctadecane (69 per cent yield). We have now applied the method to mixed couplings of the following types:

$$F(CH_2)_nCOOH + HOOC(CH_2)_mCOOR \rightarrow F(CH_2)_{n+m}COOR + 2\ CO_2 + H_2;$$

$$F(CH_2)_nCOOH + HOOC(CH_2)_mCl \rightarrow F(CH_2)_{n+m}Cl + 2\ CO_2 + H_2.$$

Thus, 10-fluorodecanoic acid with methyl hydrogen sebacate forms methyl 18-fluorostearate, and with 5-chlorovaleric acid forms 13-fluorotridecyl chloride.

Summary. Representative members of various chemical species containing an ω-fluorine atom have been prepared and tested on mice by subcutaneous injection; chemical classes described in this article include ω-fluoroalkyl halides, ω-fluoroalkenes and ω-fluoroalkynes, ω-fluoroalkyl thiocyanates, ω-fluoroalkyl mercaptans, ω-fluoroalkanesulphonyl chlorides and fluorides, miscellaneous ω-fluoro sulphur compounds, and certain fluorinated analogues of significant pharmacological compounds. An attempt has been made to correlate the toxicities with known metabolic mechanisms: the results and conclusions exemplify a simple and clear-cut method of demonstrating *in vivo* conversions of certain functional groups in aliphatic compounds. The preparation and synthetic uses of these fluorine compounds have been surveyed briefly. Full details of preparation, physical constants and analytical data, together with a more complete bibliography, will be presented in the appropriate journals in due course.

We are indebted to the Defence Research Board of Canada for funds to provide salaries, chemicals and apparatus (Contract DRB *X*-24) and for permission to publish this work (DRB Report No. SW-1). We are very grateful to Drs. M. K. McPhail and F. C. G. Hoskin and Mr. P. A. Adie, Suffield Experimental Station, Ralston, Alberta, for carrying out the toxicity determinations, and to Dr. F. E. Shideman, University of Wisconsin, for testing the fluorobarbiturates as central nervous depressants. The following have collaborated in this work: G. M. Brown, R. R. Fraser, W. C. Howell, W. C. McMurray, J. E. Millington, J. J. Norman, J. B. Stothers and R. W. White. [May 3.

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LETTERS TO THE EDITORS

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Growth-regulating Activity of Certain 2 : 6-Substituted Phenoxyacetic Acids

In recent studies[1–4] of the mechanism of action of plant growth-regulating compounds it has been postulated that active phenoxyacetic acids become attached at two points to a specific substrate within the cell, the points of attachment being the carboxyl group and a position in the ring *ortho* to the side-chain. So far, phenoxyacetic acids substituted in the 2- and 6-ring positions have not been regarded as active in the *Avena* straight-growth test. On the basis of other tests it has been put forward that high activity in chlorophenoxyacetic acids is associated with the presence of two unsubstituted positions in the ring *para* to each other. It has also been claimed that 2 : 6-dichlorophenoxyacetic acid and 2 : 4 : 6-trichlorophenoxyacetic acid are not themselves active but behave as anti-auxins. That is, when these compounds are mixed with either indolylacetic acid or 2 : 4-dichlorophenoxyacetic acid the resulting stimulation in extension growth of *Avena* coleoptiles is less than that induced by indolylacetic acid or 2 : 4-dichlorophenoxyacetic acid alone. Evidence of this type has led to the proposal that 2 : 6-substituted compounds have only a single point of attachment to the substrate and act as anti-auxins by blocking one of the two-point attachments of other more active compounds. From experiments carried out in this Department, however, it is now clear that the interpretation of the above results requires further consideration.

Table 1. Activity of some 2 : 6-Substituted Phenoxy Acids in the Went Pea Curvature Test and *Avena* Extension Growth Test. Measurements after 24 Hours

Compound	Split pea stems		*Avena* coleoptiles	
	Optimum conc. (molar)	Max. degree curvature	Optimum conc. (molar)	Max. ext. growth % of control
2 : 4-Dichlorophenoxy-acetic acid	5×10^{-5}	304	5×10^{-5}	149
2 : 6-Dichlorophenoxy-acetic acid	$1{\cdot}25 \times 10^{-4}$	238	—	—*
,, -propionic acid	$2{\cdot}5 \times 10^{-5}$	286	10^{-4}	60
,, -butyric acid	5×10^{-4}	210	$2{\cdot}5 \times 10^{-4}$	60
2 : 6-Dimethylphenoxy-acetic acid	6×10^{-4}	43	—	—*
,, -propionic acid	$2{\cdot}5 \times 10^{-4}$	146	$7{\cdot}5 \times 10^{-4}$	24
,, -butyric acid	5×10^{-5}	211	$2{\cdot}5 \times 10^{-4}$	24
,, -valeric acid	5×10^{-5}	114	—	—*
2 : 4 : 6-Trichlorophenoxy-acetic acid	$2{\cdot}5 \times 10^{-4}$	73	—	—*
,, -propionic acid	$2{\cdot}5 \times 10^{-5}$	117	—	—*
2-Methyl-4 : 6-dichlorophenoxy-acetic acid	$1{\cdot}5 \times 10^{-4}$	67	—	—*
,, -propionic acid	$2{\cdot}5 \times 10^{-5}$	153	—	—*

* No statistically significant increase in extension growth

A series of 2 : 6-substituted phenoxyacetic acids with alkyl substitutions in the side-chain was synthesized and tested over a wide concentration-range in the Went pea curvature and *Avena* straight-growth tests. The results for curvature and extension growth after the conventional period of twenty-four hours are given in Table 1.

All the compounds induced curvature in the pea test and in every case substitution of methyl or ethyl groups in the side-chain resulted in an increase in activity. Only the α-methyl and α-ethyl substituted acetic acids of the 2 : 6-dichloro- and 2 : 6-dimethyl-phenoxy acids induced a statistically significant increase in straight growth in the *Avena* test. The fact that activity can be obtained when electro-positive (chlorine) or electronegative (methyl) substituents are present in the ring is not in accord with previous electronic considerations of growth-regulating activity.

On the basis of the data recorded at the end of twenty-four hours none of the acetic acids which were unsubstituted in the side-chain induced extension growth of the *Avena* coleoptile. However, when measurements are made at intervals of 2, 4, 6, 9, 12 and 24 hr. different conclusions are reached. At a concentration of 125 p.p.m. of the 2 : 6-dichlorophenoxyacetic acid, extension growth was increased over that of the controls by 39 and 21 per cent at the end of 4 and 6 hours respectively, followed by growth inhibition at 9, 12 and 24 hours. On the other hand, no positive response was obtained with the 2 : 6-dimethyl-, 2 : 4 : 6-trichloro- or 2-methyl-4 : 6-dichlorophenoxyacetic acids.

Experiments carried out with segments of pea internodes have shown that extension growth is directly proportional to water uptake[5]. Using the latter as a measure of growth, it was found that 2 : 6-dimethylphenoxyacetic acid between 200 and 1,000 p.p.m. brought about a statistically significant increase in water uptake over that of controls after 4 and 6 hours, whereas no increase was apparent in measurements made at other time-intervals up to 24 hours.

When measured droplets of any of these compounds were applied to the adaxial surface of the first pair of leaves of four-leaf sunflower seedlings, it was found that concentrations more than two hundred times that of 2 : 4-dichlorophenoxyacetic acid were required to give a similar growth response. Such differences suggest that although these compounds are active when they have reached the site of action, they may penetrate slowly or are not readily translocated.

It would seem clear, therefore, that 2 : 6-substituted phenoxyacetic acids can no longer be simply classified as inactive compounds or as anti-auxins.

Further details of this work are being published elsewhere.

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Stimulation of the Discharge of Gametangia from a Brown Alga by a Change from Light to Darkness

WHILE studying the polarity of the *Fucales* egg, I observed in 1951 that isolated receptacles of *Pelvetia fastigiata* could usually be stimulated to discharge gametangia by exposure to a brief period of darkness following a longer period of illumination. Thenceforth, gametes of *Pelvetia* have been obtained routinely by this means. It was further observed, especially at lower temperatures, that the shedding stimulus was sometimes transmitted from one region of a receptacle to another. Since no similar observations on algae have been published, and since the *Fucales* egg is an attractive object for embryological investigation, a brief report may be of interest.

Material was collected at Corona del Mar, California. Mature receptacles were cut free at their bases, brought indoors, and allowed to become air-dry until liquid was no longer visible upon them. Then they were placed inside a covered jar which was in turn inside an ice-cooled 'Thermos' jug and transported to the Earhart Plant Research Laboratory in Pasadena, where they were stored in closed jars, still dry, in the dark, and at 6° C. Even after more than two weeks of such storage, receptacles have yielded gametes which united to form zygotes showing more than 95 per cent normal germination.

The light–dark response was found to be weak or absent in receptacles stimulated before two or three days of such storage. Therefore, after at least two days of such storage, receptacles were transferred to sea-water at 16° or at 9° C. and were illuminated by about 500 ft.-candles of white light free from infra-red radiation. Receptacles that had been stored for relatively long times often extruded some gametangia while being illuminated, but such shedding did not affect the subsequent response to darkening.

Receptacles that were transferred to darkness after two hours of illumination did not respond; but those transferred after four or more hours of illumination usually began to shed eggs rapidly within ten minutes and yielded up to 10,000 eggs per receptacle within half an hour. Examination of the process of gamete liberation with a hand lens showed the oogonia being ejected from each ostiole one at a time, often succeeding each other so rapidly as to form long rows like green beads on a string. No upper limit to the effective light period was found; darkening after as long as 450 hr. of illumination evoked shedding in the usual manner. A dark period as short as 3 min. followed by a return to the original illumination brought forth the usual shedding ten minutes later. Thus shedding may be induced by a dark period so short that the discharge of gametangia begins and continues in the light.

In some experiments receptacles were illuminated in the usual way, and then only about one-half (basal or apical) of each receptacle was darkened, the other end remaining undisturbed in the same light. The darkened ends of the receptacles responded by discharging gametangia as usual and in many cases the other, still illuminated, ends also responded. This transmission of the shedding stimulus was observed to occur to a very much greater degree among experiments conducted at 9° C. than at 16° C.

I am indebted to Dr. Frits Went and to Dr. Anton Lang for their encouragement and aid in preparing this communication and to Dr. Gilbert Smith for identifying the species used. The work reported was carried out while I held a United States Atomic Energy Commission predoctoral fellowship.

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Abnormal Growths associated with Wool Follicles in Sheep

Burns and Clarkson[1] described 'capsules' in sheep skin which, when traced up towards the skin surface, were apparently degenerate follicles. Similar roughly spherical bodies have now been seen free in the dermis. These usually had lumina like the 'capsules' mentioned above and, although smaller, could presumably have arisen from degenerate follicles by disruption at a point on the longitudinal axis of the follicle. Thus, when in samples taken at different ages from various sheep breeds, these bodies were observed attached to the base of an otherwise normal follicle, usually not far above the bulb (Fig. 1), they were thought to have become secondarily attached. However, in this figure the connective tissue sheath can be seen to be split and 'pushed away' from the follicle, and in preparations stained with cyanol to show blood vessels[2] the capillary network of the follicle has been seen to extend around these bodies. This suggests that the body had, in fact, been formed as an outgrowth from the follicle and had not become secondarily attached. When one was seen in a sheep vibrissal follicle within the blood sinus, the suggestion of secondary attachment seemed untenable.

In Figs. 2 and 3 this body can be seen to be attached by a long stalk to the outer root sheath immediately below the sebaceous gland. In this instance one can see in the body a series of concentric zones having the appearance of stratum corneum. These are arranged around a spheroidal centre of homogeneous appearance which apparently contains some melanized granules. Most of the bodies, however, contain a lumen which in many instances appears to be collapsed. It is possible, therefore, that some of the bodies seen free in the skin represent outgrowths which have become detached from the follicle, and are not proximal parts of degenerate follicles. In

Fig. 1. Abnormal body attached to wool follicle. × c. 265

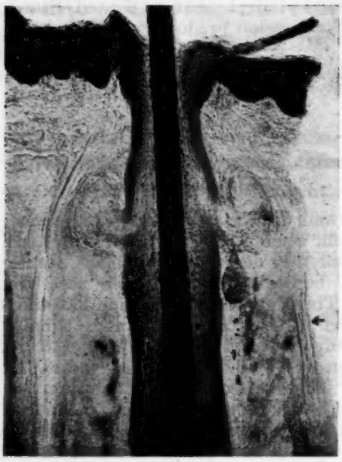

Fig. 2. Vibrissal follicle with an abnormal body. Wall of the sinus is indicated by an arrow. 150 μ frozen section. × *c.* 65

at least one large 'capsule' with a lumen, which may have arisen as an 'outgrowth' or from a degenerate follicle, foreign body giant cells were observed. This tends to support the suggestion that bodies with a lumen represent a later stage than those containing a central spheroid. The structures described here are smaller in size than the 'capsules' of Burns and Clarkson[1]; they are most comparable with their 'type D capsule' in which a second lumen exists for a distance up the follicle. Thus their 'type D capsule' may be identical with the bodies seen here, and may not fit in with the series of degeneration they suggested.

Certain stages of the cysts produced experimentally by Wolbach[3] in the mouse appear to be of a similar relative size to the 'capsules' of Burns and Clarkson and apparently have the same origin from an entire region of a follicle and not from an appendage.

Pinkus[4] described outgrowths of the human follicle wall in which there were keratinized 'beads'; he did not mention a lumen as observed here. It is interesting that a lumen might arise independently from the follicle lumen, and that keratinization morphologically comparable with stratum corneum might arise independently from the skin surface, as appears to happen in the formation of hair canals (cf. Wildman's[5] Plate 2). On the other hand, laminæ similar to stratum corneum might arise by re-absorption of solid keratinous structures[6].

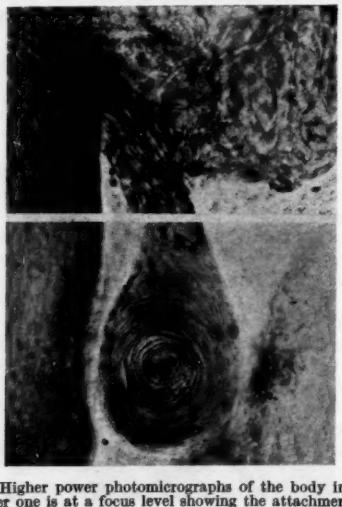

Fig. 3. Higher power photomicrographs of the body in Fig. 2. The upper one is at a focus level showing the attachment to the follicle wall beneath the sebaceous gland. The lower one shows the internal structure. × *c.* 300

One of us (M. L. R.) is studying the blood supply to follicles, hence the preparations to show the blood sinus of vibrissal follicles. It is noteworthy that in contrast to some other mammals (cf. Davidson and Hardy[7]) the vibrissal follicles of sheep lack a ring-wulst (Fig. 2).

We are indebted to Dr. G. M. Bonser, of the School of Medicine, Leeds, for a most helpful discussion of these observations.

Our thanks are due to the Council of the Wool Industries Research Association for permission to publish these observations, also to Mr. H. M. Appleyard and Miss M. E. A. Perkin for preparing the photomicrographs.

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Biological Acetylation of Isoniazid

In the course of investigations involving sulphonamide acetylation it was observed that the acetylation of sulphanilamide by pigeon liver extracts was markedly inhibited by isoniazid (*iso*nicotinylhydrazide) (unpublished results). By means of the procedure of Lineweaver and Burk[1] the inhibition was found to be competitive in nature. The probability that the inhibition was of the competing substrate type was increased by the recent findings of Hughes[2] and others[3] that, following the administration of isoniazid to man and monkeys, 1-*iso*nicotinyl-2-acetylhydrazine appears in the urine. It has now been found that isoniazid is readily acetylated by pigeon liver extract, and that substances which inhibit sulphanilamide acetylation also inhibit the acetylation of isoniazid.

Acetone-dried pigeon liver was prepared as previously described[4]. The dry powder was extracted by grinding in a mortar for 5 min. with a medium

Table 1. Acetylation of Isoniazid by Pigeon Liver Extract

Additions	Isoniazid recovered (μgm.)	Isoniazid acetylated (μgm.)	Isoniazid acetylated (per cent)
None	316	4	1
Adenosine triphosphate	266	54	17
" + acetate	141	179	56
" + citrate	178	142	44

Vessel components, pigeon liver extract 1 ml. (corresponding to 60 mgm. of acetone powder), potassium phosphate buffer, *p*H 7·4, 0·02 *M*, isoniazid initially added 320 μgm.; other additions as indicated: adenosine triphosphate 0·004 *M*, potassium acetate 0·02 *M*, potassium citrate 0·02 *M*. All concentrations are final in a total volume of 3 ml.; 90 min. incubation at 37° C.

Table 2. Inhibition of Isoniazid and Sulphanilamide Acetylation in Pigeon Liver Extracts

Exp. No.	Additions	Isoniazid acetylated (μM)	Inhibition of isoniazid acetylation (per cent)	Sulphanilamide acetylated (μM)	Inhibition of sulphanilamide acetylation (per cent)
1	Isoniazid	1·51	—	—	—
	Sulphanilamide	—	—	0·90	—
	Isoniazid, sulphanilamide	1·05	30	0·30	68
2	Sulphanilamide	—	—	1·22	—
	Sulphanilamide, *p*-aminosalicylate	—	—	0·76	38
	Sulphanilamide, 6-aminonicotinamide	—	—	0·70	43
3	Isoniazid	1·12	—	—	—
	Isoniazid, *p*-aminosalicylate	0·60	46	—	—
	Isoniazid, 6-aminonicotinamide	0·58	48	—	—

Vessel components: 1 ml. of pigeon liver extract (corresponding to 60 mgm. acetone powder); 60 μM potassium phosphate buffer (*p*H 7·4); 60 μM acetate; 60 μM citrate; 9 μM adenosine triphosphate; other additions as indicated: Exp. 1, 2·92 μM isoniazid; 2·61 μM sulphanilamide; exps. 2 and 3, 2·33 μM sulphanilamide; 2·33 μM isoniazid; 3 μM *p*-aminosalicylate; 3 μM 6-aminonicotinamide. Total volume 3 ml.; 90 min. incubation at 37° C.

composed of 0·09 *M* potassium fluoride and 0·06 *M* potassium chloride in the proportion of 60 mgm. powder per ml. of extraction medium. The supernatant obtained after centrifugation at 3,000 r.p.m. for 20 min. was used as the source of acetylating enzyme.

Sulphanilamide was estimated by the method of Bratton and Marshall[5]. A modification of the chlorodinitrobenzene method of Scott[6] was used for the estimation of isoniazid. Acetylated isoniazid, which does not react with the colour reagent, was determined as the difference between the control and incubated samples. This method will be described in detail elsewhere.

As shown in Table 1, isoniazid, when incubated with pigeon liver extract in the absence of adenosine triphosphate, was almost quantitatively recovered. This indicates that isoniazid is not destroyed by pigeon liver extract and that its disappearance, therefore, can safely be attributed to conjugation. The addition of acetate and adenosine triphosphate to the system resulted in the acetylation of 56 per cent of the isoniazid initially added. Citrate as an acetyl precursor[7] was less effective than acetate. The slight acetylation which takes place upon the addition of adenosine triphosphate alone is undoubtedly due to residual acetate or acetyl precursors in the crude extract. From the point of view of acetylation, isoniazid and sulphanilamide when present together are mutually inhibitory. Thus, when 2·92 μM of isoniazid and 2·61 μM of sulphanilamide were added to the system (Exp. 1 of Table 2), a lower amount of each was acetylated than when either was present separately. This suggests that the same enzyme may be involved in the acetylation of both compounds. The same suggestion may be found in the fact that *p*-aminosalicylate and 6-aminonicotinamide inhibit the acetylation of both isoniazid and sulphanilamide (Exps. 2 and 3, Table 2).

Hughes[2] has discussed the chemotherapeutic significance of isoniazid acetylation. The inhibition of isoniazid acetylation by *p*-aminosalicylate is of some interest in this regard. The apparent synergism which obtains when isoniazid and *p*-aminosalicylate are used in combination in tuberculosis therapy[8] may be due, partially, to the inhibition by *p*-aminosalicylate of isoniazid acetylation. When isoniazid and *p*-aminosalicylate are administered in combination to rabbits, the free-isoniazid blood-levels 4 hr. after dosage are twice as high as those attained when the same dose of isoniazid is given alone (unpublished results). Bernstein *et al.*[9] have shown that acetylisoniazid has less than one-five-hundredth the activity of the parent compound against the tubercle bacillus *in vitro*, while *in vivo* the parent drug is at least one hundred times more active than the acetyl derivative. It might be expected, therefore, that *p*-aminosalicylate would be instrumental in enhancing the *in vivo* activity of isoniazid against tubercle bacillus infections by maintaining elevated and prolonged therapeutic blood-levels of free isoniazid.

The technical assistance of Mr. Julius Gordon is gratefully acknowledged.

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Extraction of ACTH from Human Pituitaries

ACTH is prepared mainly from hog pituitaries for medicinal purposes, and Marshall[1] showed conclusively that it was localized in the basophil cells of the anterior hypophysis in that animal. So far as we are aware, ACTH has not been extracted previously from human pituitaries, although lyophilized pituitary tissue has been assayed[2].

Eighteen human pituitaries from cases with no evidence of a primary endocrine disorder were used for the extraction of ACTH, and all but two were removed within seven hours of death. In almost all cases a thin slice of the anterior hypophysis was taken for histological study and the posterior lobe removed. The bulk of the anterior hypophysis was then placed in deep freeze until sufficient material had been collected. The time in deep freeze of individual glands varied from a few days to six weeks.

The glands were then acetone-dried and finely powdered to give 1·30 gm. of dry powder. The powder was extracted with 75 per cent acetone at *p*H 2·0 and the active material precipitated with an excess of acetone, yielding 119 mgm. of ACTH with an activity of 2·24 I.U. ± 26 per cent per mgm.

Clearly this yield of ACTH from human pituitaries, namely, 205 u. per gm. of dry powder, is as good as

that obtained from the best batches of pig glands despite the greater interval which elapsed between death and their collection. The histological changes produced in the basophils in Cushing's syndrome[3], as a result of cortisone therapy[4], in Addison's disease[5] and in conditions of stress[6], provide indirect evidence that in man, also, ACTH is formed in these cells of the anterior hypophysis. If this is the case, there is little doubt that the degranulation of the basophils occurring as a result of stress must have some influence on the yield of ACTH, and this problem is in the process of further investigation.

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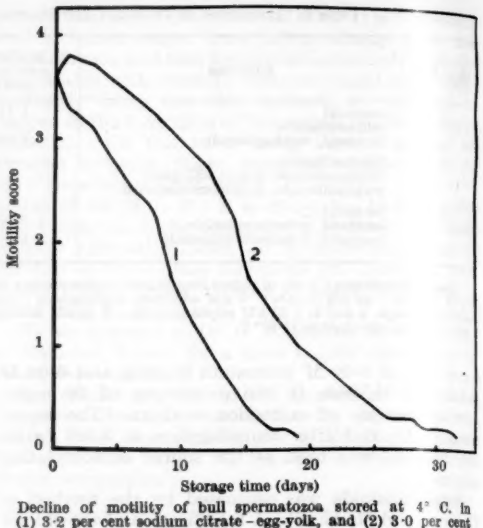
Effect of Glycine on the Survival of Bull Spermatozoa *in vitro*

Bull semen for artificial insemination is usually stored at 4° C. in media composed of equal volumes of either phosphate buffer (*p*H 7·4) or citrate buffer (*p*H 6·8) and fresh egg-yolk[1]. Under these conditions the motility and fertilizing capacity of spermatozoa decrease rapidly with time, and in practice samples are not used for insemination for more than three days after collection. Semen can be successfully stored for much longer periods at − 79° C.[2], but this technique has disadvantages for everyday use.

Since evidence has been obtained suggesting that bovine spermatozoa are adversely affected by phosphate and citrate buffers[3], attempts have been made to improve sperm survival at 4° C. by replacing these buffers (that is, the non-egg-yolk part of the diluent) with other solutions. In this connexion we have observed that sperm motility declines less slowly when the conventional citrate buffer (3·2 per cent sodium citrate) is replaced by Sørensen's glycine buffer (0·75 gm. glycine, 0·58 gm. sodium chloride, water to 100 ml.)[4]. Afterwards it was found that solutions of pure glycine, with equal volumes of egg-yolk, were more effective in bringing about this improvement and that sperm survival increased with increasing glycine concentration in the non-egg-yolk fraction up to levels of at least 4 per cent (0·53 *M*). Data illustrating the improved survival of spermatozoa stored in 3 per cent glycine–egg-yolk as compared with those stored in 3·2 per cent sodium citrate–egg-yolk are summarized in the accompanying figure. These results, mean observations on ten split ejaculates each diluted ten times, show that the decline of motility during storage is slower in glycine–egg-yolk and that the mean half-life of the spermatozoa in this diluent (as judged by motility) is increased



Decline of motility of bull spermatozoa stored at 4° C. in (1) 3·2 per cent sodium citrate – egg-yolk, and (2) 3·0 per cent glycine – egg-yolk

by six days. The addition of electrolytes (sodium hydroxide, Ringer solution, 0·9 per cent sodium chloride, phosphate and citrate buffers) to the glycine–egg-yolk appears to have an adverse effect on sperm survival; on the other hand, there is evidence that the addition of small amounts of fructose and small amounts of arginine (which increases *p*H) individually increase sperm survival. In one instance a semen sample diluted with a glycine–fructose–egg-yolk medium appeared good enough for insemination after 50 days storage and still contained some progressively moving spermatozoa after sixty-five days. In all experiments, however, there has been considerable variation in sperm survival between semen samples.

Preliminary observations indicate that the survival of boar and stallion spermatozoa is also enhanced by glycine.

Tyler and co-workers[5] have shown that glycine prolongs the life-span of spermatozoa of the sea urchin, domestic fowl and bull. The mean half-life of bull spermatozoa at 38·6° C. was increased in their experiments from 5·9 to 7·2 hours by 0·038 *M* glycine in balanced saline, but there was no improvement at 4° C. and the effect of glycine in conjunction with egg-yolk was not studied. Tyler and Rothschild[6] found that the metabolism of sea urchin spermatozoa is affected by glycine although glycine is not metabolized to any measurable extent. They suggest that the beneficial effect of glycine is due to chelation of heavy metals, but if this were a complete explanation a maximal response would be expected at fairly low glycine concentrations. The present results show that maximal survival of bull spermatozoa is not obtained until the final glycine concentration, excluding that originally present in the egg-yolk, is at least 0·26 *M*, and that some property of glycine other than its chelating action must be at least partially responsible for its effect. Because electrolytes are known to stimulate the activity of mammalian spermatozoa and probably, therefore, shorten their survival, the favourable effect of glycine as compared with citrate buffer may be due to its low electrolyte content. It is also possible that as an essential

precursor of certain biologically important substances such as sarcosine, creatine and adenosine, glycine plays an important part in maintaining the functional integrity of the sperm cell.

Experiments are now being carried out to determine the effect of glycine on the fertilizing capacity of bull spermatozoa.

One of us (A. R.), on leave of absence from the College of Veterinary Science, Mathura, India, is greatly indebted to Dr. John Hammond for the provision of research facilities and to the Nuffield Foundation for a Dominion Fellowship.

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Cultivation of *Pasteurella tularensis* in Chemically Defined Media: Effect of Buffers and Spermine

Pasteurella tularensis is generally considered to be a fastidious micro-organism, difficult to cultivate in artificial media[1,2]. Tamura and Fleming[3], in a preliminary report, briefly announced the cultivation of *P. tularensis* in a synthetic medium with cocarboxylase, adenylic acid, adenosine diphosphate or adenosine triphosphate as the critical growth factors.

With the strains at our disposal we were unable to demonstrate any growth-promoting effect of adenosine triphosphate when added to various basal media. On the other hand, we observed that addition of large amounts of acid hydrolysates of proteins such as hæmoglobin to a basal medium composed of glucose, cysteine, sodium chloride, salts *A* and *B*[4] and thiamine, enabled good growth of all the ten *P. tularensis* strains tested.

The growth-promoting effect of hæmoglobin was traced to the high histidine content of the globin moiety. In fact, graded amounts of histidine, added to a basal medium composed as above, with vitamin-free casein acid hydrolysate as source of amino-acids, produced, up to 5 mgm./ml., a nearly linear growth-response. Analogous results were obtained when casein hydrolysate was replaced by a mixture of amino-acids, similar to that described by Mills *et al.*[5], namely, *l*-arginine (200 μgm./ml.), *l*-aspartic acid (200 μgm./ml.), *l*-cysteine (100 μgm./ml.), *dl-iso*leucine (200 μgm./ml.), *dl*-leucine (200 μgm./ml.), *l*-lysine (200 μgm./ml.), *dl*-methionine (200 μgm./ml.), *l*-proline (1 mgm./ml.), *dl*-serine (200 μgm./ml.), *dl*-threonine (1 mgm./ml.), *l*-tyrosine (200 μgm./ml.), *dl*-valine (200 μgm./ml.) (Fig. 1).

dl-Histidine as well as *d*-histidine were found to be as effective, on a quantitative basis, as *l*-histidine,

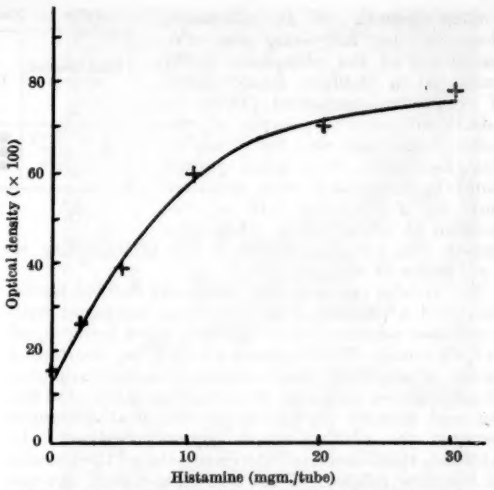

Fig. 1. Growth response of *P. tularensis* to graded amounts of histidine

provided that the medium contained a minimal amount of *l*-histidine (50–100 μgm./ml.). This result suggested a dual function of histidine: as an essential metabolite active in its *l*-form only, and by its physico-chemical properties independent of the optical configuration.

Since histidine is known as a potent chelating agent, it was first assumed that its physico-chemical effect on growth may be ascribed to a metal-binding mechanism. The finding that other metal-complexing substances such as histamine and even chemically unrelated compounds like glycylglycine and sodium pyrophosphate exhibited similar growth-promoting activity appeared to lend support to this assumption (Table 1). On the other hand, it was difficult to reconcile with this hypothesis the fact that other known chelating compounds such as citrate, tartrate and versene (ethylene diamine tetraacetate) failed to sustain growth. Changing the mineral composition of the medium did not significantly affect growth.

While looking for an alternative and a more satisfactory explanation, it was noticed that all the active compounds had in common the property of being strong buffers with a *pK* value of about 8–9. This suggested the trial of other buffers of the same *pK* range such as tris [tris (hydroxymethyl) aminomethane], and diglycylglycine[6], substances which apparently do not possess any significant metal-complexing capacity. Tris and diglycylglycine proved to be nearly as effective as histidine in sup-

Table 1. Effect of Buffering Agents on the Growth of *P. tularensis* (Strain 176) in a Chemically Defined Medium

30 mgm. of each buffering agent was added to 5 ml. of basal medium. The basal medium is composed of the thirteen amino-acids mentioned in the text (histidine in amount of 100 μgm./ml.), thiamine 2 μgm./ml., 1 per cent glucose, 0·9 per cent sodium chloride, salts *A* and *B* (ref. 4). Growth was measured in terms of per cent transmission in a Coleman spectrophotometer at 550 mμ

Buffering agent added	Growth (48 hr.)
None	85
Histidine	15
Histidylhistidine	20
Histamine	15
Glycylglycine	28
Diglycylglycine	28
Sodium pyrophosphate	30
Tris	26
Salts *A*	50

porting growth of *P. tularensis*. Moreover, by increasing the concentration of the phosphate buffer (salts *A*) a definite improvement of growth was achieved (Table 1). Additional proof in favour of the buffer hypothesis was furnished by the observation that good growth could be correlated with maintenance of a constant *p*H of the medium at about 7–7·5, while poor growth was accompanied by a rise of alkalinity to a *p*H value of about 8.

Table 1. Neutralization Reaction of Jaundice Virus by Human Serum

Final dilution of virus	Distilled water	Serum of person working on silkworm jaundice virus		Serum of person not working on silkworm jaundice virus
		A	*C*	*I*
$\frac{1}{2} \times 10^{-4}$	● ● ● ● ●	● ● ● ● ●	● ● ● ● ●	● ● ● ● ●
$\frac{1}{2} \times 10^{-5}$	● ● ● ● ○	● ● ○ ○ ○	● ● ● ○ ○	● ● ○ ○ ○
$\frac{1}{2} \times 10^{-6}$	● ● ● ○ ○	● ● ○ ○ ○	● ● ○ ○ ○	● ● ○ ○ ○

● Died of silkworm jaundice. ○ Alive

The growth curve in the chemically defined media exhibited a prolonged lag period as compared with a proteose peptone broth, the final yield being equal in both media. In the search for this 'lag shortening factor' it was found that addition of minute amounts (5 μgm./ml.) of spermine or spermidine eliminated the lag and thereby abolished the observed difference between the synthetic and peptone medium. In addition, the presence of spermine reduced the amount of histidine needed. With spermine added, optimal and rapid growth could be secured by merely increasing the concentration of the phosphate buffer to 0·02 *M*. Putrescine, cadaverine and agmatine were also active, but to a smaller extent.

The mechanism by which spermine exerts its effect is being investigated. Results will be presented in a detailed report.

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Neutralization of Silkworm Jaundice Virus by Human Serum

It is well known that immunized rabbit serum neutralizes the virus of silkworm jaundice, but there seems to be no information on the effect of human serum. Human sera were obtained from people working on silkworm jaundice virus and from others. Supernatant fluid from the infected larval blood was used as the virus solution. Usually the pupæ injected with about 5–1,000 ml. of 10^{-6} diluted infected larval blood all died from jaundice. The diluted virus solution and an equal volume of the serum or distilled water were mixed and maintained at room temperature for 30 min. After this treatment, about 5–1,000 ml. of the mixture was injected into healthy silkworm pupæ, which were observed for 10 days[1].

The results (Table 1) show that there is scarcely any difference in the neutralizing titre between sera of people engaged in work on silkworm jaundice virus and others.

But it was found that the latent periods of the pupæ injected with the serum were shorter than that with the distilled water in each virus dilution as shown in Fig. 1 (final dilution of the virus is $\frac{1}{2} \times 10^{-4}$), Fig. 2 ($\frac{1}{2} \times 10^{-5}$) and Fig. 3 ($\frac{1}{2} \times 10^{-6}$). The latent period of the silkworm jaundice virus depends upon the virus multiplication[1]. Hence, in the case of injecting the virus with human serum, the virus

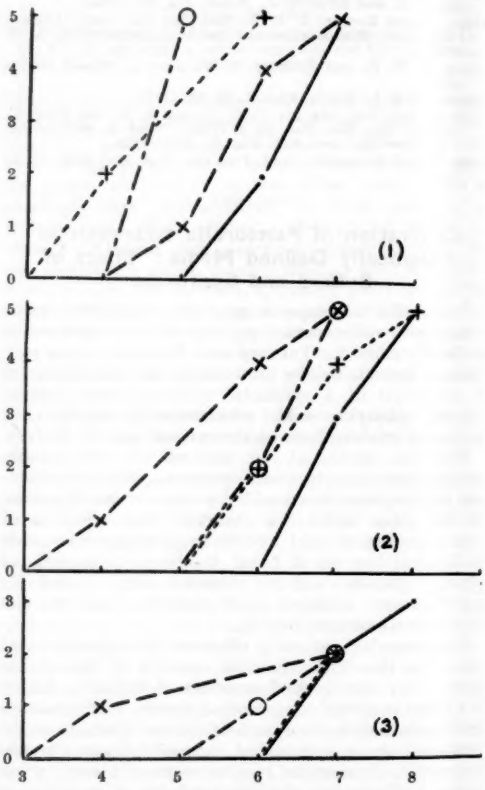

Fig. 1. Total number of jaundiced silkworms after virus inoculation (final dilution of the virus is $\frac{1}{2} \times 10^{-4}$). Ordinate: total number of jaundiced silkworms. Abscissa: days after virus inoculation. ——, Virus injected with distilled water; +···+, neutralization by *A* serum; O– – –O, neutralization by *C* serum; × — — ×, neutralization by *I* serum

Fig. 2. Total number of jaundiced silkworms after virus inoculation (final dilution of the virus is $\frac{1}{2} \times 10^{-5}$). Ordinate and abscissa, as Fig. 1

Fig. 3. Total number of jaundiced silkworms after virus inoculation (final dilution of the virus is $\frac{1}{2} \times 10^{-6}$). Ordinate and abscissa, as Fig. 1

increases more rapidly than that with the distilled water. Accordingly, it may be considered that the serum contains a viral growth factor.

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Electron-Track Autoradiography of Radioactive Frog Embryos

Beta-track autoradiographs offer advantages over other methods of autoradiography, especially when small quantities of weak emitters such as carbon-14 are used[1]. If, in addition, the autograph and tissue can be viewed as a unit, a further advantage is gained[2]. Such preparations permit detection of the characteristic tracks in the presence of heavy background fog; eliminate the problem of spurious interpretation due to the reduction of the silver grains by tissue constituents[3]; require far less radioactivity for detection than other methods of autoradiography; permit viewing at high magnifying power with consequent localization of radioactivity to small areas; and eliminate matching of tissue and autograph. Beta tracks, due to their tortuous path, do not permit determination of a point source.

Radioactive frog (*Rana pipiens*) ova and embryos were produced by injecting sodium formate-^{14}C into the gular lymph sac of females, which were then induced to ovulate by an intraperitoneal injection of pituitaries. Fertilized ova were permitted to develop, and specimens were fixed in absolute alcohol at various developmental stages[4], cleared in oil of wintergreen and embedded in paraffin. Serial sections were cut at 10 μ, floated on absolute alcohol on to slides coated with albumen, and dried.

For preparation of the autographs, the paraffin was removed with xylol and the slides dried at 40° C. on a warm plate. Several drops of Ilford *G*-5 emulsion gel, melted at 45° C., were placed on each warm slide, and the emulsion brushed over the sections with a camel's-hair brush held in a quill. The slides were cooled to room temperature to allow the gel to harden, placed in a lead-shielded dark receptacle for 23 days, and then developed in amidol for 15 min. (amidol, 1·5 gm.; sodium sulphite, 3·5 gm.; sodium bisulphite, 0·5 gm.; distilled water, 500 c.c.). This was followed by 5 min. in a stop-bath of 1 per cent acetic acid and then for 30 min. in hypo solution maintained at 5° C. The hypo was then gradually replaced with cold distilled water over a period of about 45 min. The slides were washed in running, cold tap water for several hours and dried overnight. The emulsion often adheres poorly to plain glass, so 5 per cent sodium sulphate should be added to the stop-bath to act as a hardening agent. However, if subbed-glass (gelatine-coated glass) is used, the hardening agent is not necessary. Subbed-glass can be treated just as plain glass slides are treated.

The slides are best examined with an oil-immersion lens. Emulsion covering non-radioactive areas may show an occasional electron-track which is regarded as 'background', but emulsion covering the radioactive areas exhibits many tracks, and can thus be demarcated from non-radioactive areas.

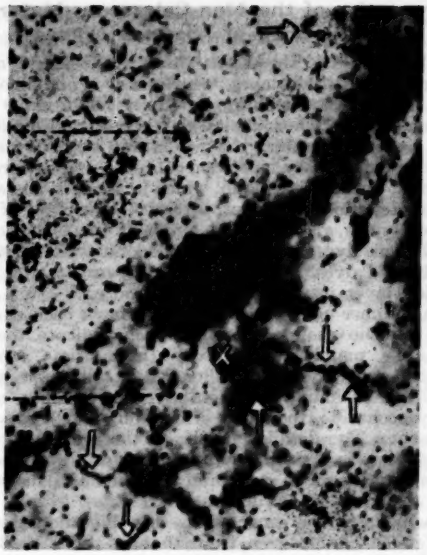

Fig. 1. Hind brain of a stage-21 larva of *Rana pipiens*, sectioned at 10 μ, showing electron tracks, some of which are indicated by arrows. *X* shows a cluster of tracks; the tissue can be seen in the background; *V* indicates the ventricle; *B* indicates the hind brain. (× 1,000)

Fig. 1 shows a portion of the hind brain and ventricle from a radioactive stage-21 larva. The tissue is out of focus, but can be seen in the background. The area in this photograph has at least forty tracks distributed in the emulsion over the tissue; but since the tracks arising from the tissue pass into the emulsion and lie in several planes, only a few can be seen clearly at any one plane of focus. One track can be seen in the ventricle at the periphery of the tissue; but beyond this area there are no electron tracks, and the radioactive area of tissue can be distinguished from the non-radioactive area of the ventricle. It is problematical that the group of tracks seen at 'X' come from a common source such as the same cell, but it can be assumed that they arose from cells in the immediate area of the field viewed.

The method of preparation outlined here loses the fatty substances of the tissue, and thus loses radioactivity. Other methods of preparation, such as freeze-drying, would preserve these and other soluble constituents. Thus, selective fixation and preparation might be used to demonstrate the presence of specified tissue substances.

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Properties of the Non-Calcareous Material in the Shell of *Anodonta cygnea*

The shell in the Lamellibranchia consists of a number of distinct layers which show a fundamental similarity in structure in related regions of valve and ligament[1]. In *Anodonta*, all parts of the shell, except the periostracum and the fusion and outer layers of the ligament, are calcified and contain a non-calcareous matrix, termed conchiolin, which in sections possesses characteristic staining properties. Conchiolin of the inner layers of valve and ligament stains typically with basic dyes, outer layer conchiolin predominantly with acid dyes, and fully-formed periostracum and fusion layer usually remain uncoloured.

A number of histochemical tests have been carried out on the shell conchiolin which indicate that it consists mainly of protein (ninhydrin, xantho-proteic, arginine[2] and Millon tests), although lipoid material (sudan black stain) and possibly some polysaccharide (periodic acid–Schiff test[3]) may be present. The detailed results of these tests indicate that there is a similarity in the properties of corresponding layers of valve and ligament and also that, as reported by Trueman in *Tellina tenuis*[4], the conchiolin of the inner layers of valve and ligament differs in composition from that in the rest of the shell. The chitosan-iodine test for chitin[5] gives a slightly positive reaction with *Anodonta* conchiolin. The periostracum, fusion and outer layers give a more strongly positive reaction to the argentaffine test[6] than the inner layers, suggesting the presence of quinone-tanned proteins. Sections treated with a series of reagents devised by Brown[7] to determine the types of linkages in structural proteins dissolve almost completely only in the sodium hypochlorite solution, providing further evidence for tanning having taken place.

The amino-acid content of the conchiolin protein has been further investigated by paper chromatography. The shell was treated in four parts, namely, 'outer' layer valve (including periostracum as well as true outer layer), inner layer valve, 'outer' layer ligament (including fusion layer as well as true outer layer) and inner layer ligament. Acid hydrolysates of equal quantities of dried conchiolin from each region were run simultaneously on paper chromatograms, using phenol/water and butanol/acetic acid/water as solvents, and developed with ninhydrin. The results reveal that although the general pattern of the amino-acids produced from each hydrolysate is somewhat similar, there are some marked differences in concentration (Fig. 1). Tyrosine is relatively more abundant in the 'outer' layers of both valve and ligament and phenylalanine is more highly concentrated in the 'outer' layer of the ligament than in the inner. Arginine and certain other amino-acids, however, show relatively higher concentrations in both inner layers. These results, and, in particular, the striking similarity in amino-acid content of the 'outer' layers of valve and ligament (Fig. 1), agree in general with the responses observed to the histochemical tests for amino-acid groups.

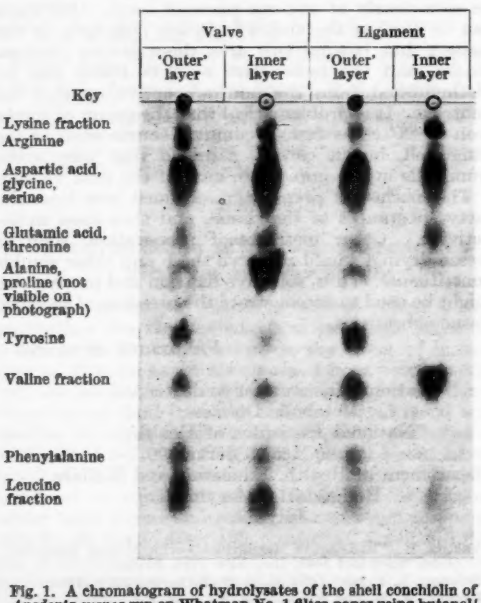

Fig. 1. A chromatogram of hydrolysates of the shell conchiolin of *Anodonta cygnea* run on Whatman No. 1 filter-paper using butanol/acetic acid/water as solvent

This work, which will be published in full later, appears to provide further evidence for the homology established on morphological grounds between the layers of valve and ligament. Moreover, the difference in composition between the conchiolin of the inner layers of valve and ligament and that in the rest of the shell, as indicated by its staining properties in sections, is reflected by the results of the histochemical tests and chromatographic analyses carried out.

I wish to thank Prof. P. G. 'Espinasse and Mr. E. R. Trueman for help and guidance and the authorities of the University of Hull for the research scholarship which has made this work possible.

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Examination of Soil Micro-organisms in their Natural Environment

Present information on the distribution and growth of micro-organisms in the soil has been obtained almost entirely by plating dilute soil suspensions on to nutrient media, the Rossi–Cholodny[1] buried slide technique, Jones and Mollison's[2] soil suspension preparations and similar indirect methods. Kubiena[3] has developed methods of examining soil organisms *in situ* using reflected light, but his observations are necessarily confined to soil surfaces. So far as we are aware, the technique of preparing thin sections of soils and non-coherent rocks for microscopical examination by transmitted light has not previously been applied to the study of soil micro-organisms in their natural environment.

In the present method, standard soil sampling and rock slicing techniques have been modified with the object of keeping the soil and soil micro-organisms as nearly as possible in their natural state. This involves keeping the stresses acting on the sample small and the temperature low. Small soil samples are taken in a polythene tube fitted with a detach-

able metal shoe and are kept in the tube throughout the staining, drying and impregnation processes. Stains and wash liquids, if used, are soaked through the samples by capillarity. The sample is rapidly dried under vacuum and vacuum-impregnated at a low temperature by a drip method using a 'Marco Resin' mixture (an unsaturated polyester manufactured by Scott Bader and Co., Ltd.).

Once the resin has matured, the sample is hard enough to be cut by the usual rock-slicing techniques without disturbance and tough enough for slices 1 mm. thick to be removed using a fairly slow speed (140 r.p.m. for a ten-inch disk) and 'Carborundum' of about 100 grade. The slices are rubbed down to any desired thickness and polished using 'Carborundum' and water; they are mounted and covered with pure canada balsam.

When sampling and impregnation are carefully carried out, there is no detectable disturbance of the soil except for a little drag at the contact of the sampler and soil, and the samples are thoroughly impregnated. The accompanying photograph of a conidial head of *Aspergillus niger* van Tiegh. in an interstitial space shows that only slight disturbance of the conidial chains has occurred during sampling and impregnation.

Sections of sandy loam and sandy clay loam prepared by this technique have a moderate to high degree of translucency even at thicknesses of several hundred microns. Algæ, fungal hyphæ and fructifications, etc., in the soil pores and on the surfaces of the mineral particles are clearly visible. Fine hyaline hyphæ, difficult to see under conditions of bright-field illumination, can be seen more easily by phase-contrast microscopy. Preliminary trials suggest that staining of the soil sample before impregnation may increase the value of the method when fine hyaline mycelia and bacteria are to be studied.

The whole process from taking the sample to examining the finished slide takes two to three days—no longer than the standard biological technique of wax embedding and microtoming. The equipment required is simple and readily made up from standard laboratory materials. A more detailed description of the method will be appearing elsewhere.

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The Second Ecdysis of Infective Nematode Larvæ

Although the second ecdysis of certain species of nematodes which parasitize sheep is known to take place in the alimentary tract of the host, the actual site is not definitely known. In the horse, some knowledge of this subject has been gained by placing larvæ in fluid from various parts of the intestinal tract[1]; but this method has not always been successful with sheep. However, it has been reported that the abomasal fluid plays a part, at least in so far as *Haemonchus contortus*[2], *Trichostrongylus colubriformis*[3] and *T. rugatus*[3] are concerned.

At this laboratory the site of exsheathment of several species has been studied in the sheep. Infective larvæ were placed in the contents of the rumen, abomasum, duodenum and ileum, and incubated at 38° C. Larvæ in 'Cellophane' sacs were also placed directly into the rumen through a rumenal fistula, and after laparotomy, into the abomasum, duodenum and ileum.

Preliminary study of the results suggests that the infective larvæ of species normally parasitic in the sheep commence to exsheath in that portion of the intestinal tract which immediately precedes the region in which the adults are normally found. *H. contortus*, *Trichostrongylus axei* and *Ostertagia circumcincta*, parasitic as adults in the abomasum, were observed to exsheath in the rumen. *T. colubriformis* and *Nematodirus* spp., parasitic as adults in the small intestine of the sheep, failed to exsheath in the rumen, but exsheathed in the abomasum, although at different rates. Whereas after an hour 90 per cent of *T. colubriformis* were exsheathed, less than 10 per cent of *Nematodirus* were exsheathed.

Oesophagostomum columbianum, a parasite of the large intestine, was not observed to exsheath in the rumen, abomasum or small intestine, although Veglia[4] has recovered exsheathed larvæ of this species from the abomasum and small intestine of the sheep.

With the exception of *Nematodirus*, larvæ normally exsheathed very rapidly, and after an hour the process may be complete in more than 90 per cent. However, considerable variations were noted in the rate of exsheathment of *H. contortus* in the rumen.

Strongyloides papillosus, a contaminant in some cultures, was observed to die if retained in the rumen for more than half an hour. This species is a skin penetrator, and its inability to survive in the rumen suggests that the success of oral infestations may be dependent on the ability of larvæ to penetrate the epithelium of the mouth, or alternatively to pass through the rumen in less than half an hour.

It is possible that the second ecdysis plays a part in determining the region of the host's intestinal tract in which the worms develop. Thus, *T. axei* is the only member of this genus to live in the abomasum, and is the only member to enter that organ exsheathed. Differences in the rate of exsheathment between *T. colubriformis* and *Nematodirus* spp. in the abomasum may be a significant factor in the relative position of these species in the small intestine, since Tetley[5] has shown that the maximum numbers of *Nematodirus* spp. are always posterior to the maximum numbers of *T. colubriformis*. The relative inability of some species of nematodes to parasitize a host, in which another species of the same genus is commonly found, may possibly be determined by differences in the rate of exsheathment within the host. Further work to elucidate these and other aspects is in progress.

I thank Mr. H. McL. Gordon, of the McMaster Laboratory, for helpful advice, and Mr. F. J. Hamilton, also of the McMaster Laboratory, for assistance with the necessary surgical operations.

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Occurrence of *Paracentrotus lividus* (Lamarck) in Scotland

Paracentrotus lividus is a littoral sea-urchin well known in the Mediterranean and on the Atlantic coasts of Europe. In the British Isles it has been recorded only in Ireland, where it is common on the south and west coasts, and occasionally in Devonshire and Cornwall[1].

It is therefore of interest to place on record that three specimens were found in 1939 in the intertidal zone of the Isle of Muck, Inverness-shire. These came from two distinct localities and the animals were living in situations similar to those inhabited by *Psammechinus miliaris* in crevices and under stones. Possibly the rock is here too hard for the urchins to burrow as is their habit in so many other localities[2]. The spines, while of the typical purple colour, are shorter and stouter than in some Irish specimens in our collection. The animals resemble closely a specimen presented to one of us by the late Prof. J. H. Orton which he collected at Looe in Cornwall in 1913.

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Effect of Alpha-Particle Bombardment on Creep in Cadmium Single Crystals

Bombardment of stressed single crystals of cadmium by alpha-particles was found by Andrade[1] to cause a marked increase in the rate of glide under certain conditions. The crystals were stressed so as to produce a creep-rate of about 0·05 per cent per min., and increases in rate of up to five times were recorded on bringing up the alpha-particle sources during the early stages of the creep curve. The effect was attributed by Andrade to the initiation of new glide planes by the intense local disturbances produced in the surface of the crystal during the impact of the energetic alpha-particles.

The present creep tests were undertaken to throw further light on this hypothesis, and in particular to determine if the effect occurred on clean crystals or whether a thin oxide film was necessary. The apparatus is very similar to that used by Andrade with the exception that the strain is measured with an optical-lever device having a magnification of 200. A cylindrical polonium alpha-particle source with an initial strength of 140 mc. produces a maximum flux of 5×10^8 particles per sq. cm. per sec. at the surface of the crystal. The flux used by Andrade was about $1{\cdot}5 \times 10^8$ particles per sq. cm. per sec.

It has not proved possible to repeat the phenomena described by Andrade. Tests have been carried out on both standard (99·9 per cent) and spectroscopic (99·99 per cent) purity cadmium crystals, 1 mm. in diameter under a variety of surface conditions produced by oxidizing the clean 'as-grown' crystals in the atmosphere for various lengths of time at 240° C. Crystals have been tested with a range of orientation ψ, the angle between the glide plane and the specimen axis, between 10° and 45°. The effect of dissolved nitrogen has also been investigated. The majority of the specimens have been tested at 0·05 per cent per minute—the rate quoted by Andrade—but tests have also been made at various rates between 0·013 and 0·26 per cent per min. The bombardment was usually initiated after about 0·5 per cent glide and the sources were brought up and removed from the specimen several times during the course of a test. A small elongation of the crystal sometimes occurred on moving the alpha-particle sources; this was traced to vibration in the apparatus and could be reduced to a minimum by very careful handling.

In specimens in which marked geometrical softening occurred as glide proceeded, due to the rotation of the glide planes towards the specimen axis with a consequent increase in shear stress, it was observed that the elongation produced by vibration would sometimes cause an increase in the rate of creep. This behaviour was observed in specimens in which the angle ψ was large and also in annealed crystals containing dissolved nitrogen. The increase in creep-rate under these conditions was independent of the position of the alpha-particle sources. In the majority of the tests, however, no change in creep-rate was detectable on bringing up or removing the sources from either the clean or the oxide-coated crystals.

Bombarding for longer periods under no load has been found to harden the crystal slightly. In one case the creep-rate of a clean spectroscopically pure crystal was reduced from 0·08 to 0·05 per cent per min. after bombardment for 2 hr. It is possible that this effect is due to the oxidation of the crystal by the oxygen ions or ozone produced in the air by the passage of the alpha-particles.

A full account of these experiments is being published elsewhere.

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The 'Oxygen-Effect' in Ionizing Irradiation

IT is a well-established fact that ionizing irradiation damages a variety of cells to a greater extent if the irradiation takes place in presence of oxygen than under anaerobic conditions. The mechanism of this 'oxygen-effect' is not yet fully understood. It is generally believed[1–4] to be due to the deleterious effect on cells by the strongly oxidizing radical HO_2 and, to some extent, by hydrogen peroxide, which are formed on X-ray irradiation in aqueous media containing oxygen, as compared with the less powerful OH radical which, in addition to reducing hydrogen atoms, is formed on irradiation in nitrogen. The exception, so far, is a bacteriophage, for which evidence has been adduced[5,6] that it has a far greater sensitivity to reducing than to oxidizing radicals.

In the work, which is reported here, bacteria representing strict and facultative aerobes and anaerobes, as well as some yeasts, were exposed to X-rays in order to study whether the 'oxygen-effect' requires the maintenance of normal respiration during irradiation and whether it bears any relation to a particular type of cellular metabolism.

Known concentrations of washed cells, suspended in phosphate buffer + glucose, were irradiated (190 kVp., no added filtration, dose-rate $6{\cdot}5 \times 10^3$ r./min.) at doses of $6{\cdot}5$–$26{\cdot}0 \times 10^3$ r. (1–4 min. irradiation). The liquid phase, during irradiation, was either free from dissolved oxygen (the gas space containing nitrogen or hydrogen) or it was in equilibrium with oxygen of decreasing percentage (100 per cent oxygen; 20 or 5 per cent oxygen in nitrogen). In some experiments with 20 per cent and 5 per cent oxygen the nitrogen was replaced by carbon monoxide. Immediately after irradiation a known amount of cells was transferred either into fresh buffer solution + glucose or into a nutrient medium in manometer flasks, and the rate of some metabolic processes measured for up to ten hours. These included: oxygen uptake, carbon dioxide production, aerobic and anaerobic fermentation or acid production and utilization of hydrogen (*Vibrio desulphuricans*). In a nutrient medium the increase, for example, in oxygen uptake or anaerobic acid production with time is proportional to the increase of dry weight of bacteria, that is, it is a true reflexion of growth.

None of the metabolic reactions measured was significantly affected by irradiation, when measured in washed non-growing cells, except aerobic fermentation of baker's yeast, which was slightly inhibited. All cells examined, however, when transferred into growth-promoting media, showed an 'oxygen-effect', that is, a stronger inhibition of growth on irradiation in presence than in absence of oxygen. The relative sensitivity for oxygen-treated as compared to nitrogen-treated samples was approximately threefold for aerobic cells, which agrees with data in the literature[1,3,4]. It was much greater, however, for a strictly anaerobic organism (*Vibrio desulphuricans*) and for spores of an aerobic organism (*B. subtilis*), which were not affected by irradiation of up to 26,000 r. in nitrogen, that is, they gave rise to vegetative forms at the same rate as the controls, while growth after irradiation in presence of oxygen (air) was strongly inhibited.

In the case of *Sarcina lutea* it has been possible to abolish almost completely the 'oxygen-effect' at doses up to 26,000 r., if cell respiration was inhibited by respiratory poisons during the irradiation. Thus, after removal of the poison, the cells behaved as if they had been irradiated in nitrogen, when judged by the degree of growth inhibition and subsequent rate of recovery. The effective inhibitors were carbon monoxide, potassium cyanide, hydroxylamine and sodium azide. Urethane did not diminish the 'oxygen-effect'.

The mode of action of the effective poisons in their role as respiratory inhibitors is known[7–9]. They all block hydrogen transfer through the respiratory enzymic system by combining with cytochrome a_3 and stabilizing the remaining respiratory enzymic chain in the reduced form. Taking this mode of action as a guide in advancing a possible explanation for the 'oxygen-effect' in irradiation, it is suggested, at least for this bacterium, that the enhancement of irradiation damage (1) involves the enzymic respiratory mechanism, (2) requires at least part of the enzymic respiratory chain to be in the oxidized form during irradiation. This makes it possible that the impedance has been caused by a reducing agent.

The results form part of a body of work which will be reported fully elsewhere.

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Effects of Crystallization on the Glass–Rubber Transition in Polyethylene Terephthalate Filaments

MULTIFILAMENT yarn spun from polyethylene terephthalate polymer ('Terylene' polyester yarn) is non-crystalline and almost unoriented. After drawing, it becomes highly oriented and moderately well crystallized[1], and in this state at room temperature it has a high initial tensile modulus, and recovers almost completely from strains of up to 1 per cent[2].

It has recently been suggested[3] that the mechanical and electrical transitions in a number of substituted acrylic polymers are characteristic of the molecular structure: the results which are given here of our investigation into the tensile behaviour of polyethylene terephthalate filament yarn show, in addition, that the visco-elastic properties of a given polymer can be considerably modified by molecular orientation and crystallization. In particular, a con-

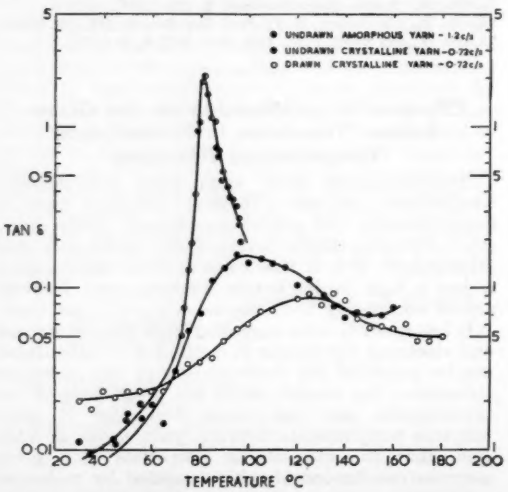
	Density (gm./c.c.)	Infra-red estimate of crystallinity[4] (per cent)	Birefringence	Transition temperature (° C.)	Half-width of loss peak curve (° C.)	Maximum value of loss tangent	Young's modulus (dynes/cm.^{2} × 10^{10})	
							Below transition	Above transition
Unoriented amorphous	1·336	2	+ 0·00	81	10	2·0	1·9	0·012
Unoriented crystalline	1·383	48	− 0·01	100	70	0·16	2·6	0·29
Oriented crystalline	1·391	65	+ 0·22	125	45	0·09	13·1	3·5

siderable movement of the 'second-order transition point' has been noted.

A temperature-range of 20°–180° C. and frequencies from 10^{-3} c./s. to 10^4 c./s. have been used, the frequency-range being divided into three sections to permit the use of convenient experimental methods. At low frequencies (10^{-3} c./s. to 10 c./s.) forced vibration was used for obtaining the load-extension hysteresis loop for strain amplitudes of up to 1 per cent. In the intermediate range (10 c./s. to 500 c./s.) the decay of free oscillations of a mass supported by the yarn is observed, while for still higher frequencies a longitudinal wave pulse propagation technique is employed. Since experimental limitations demand a decrease in amplitude with increasing frequency of vibration, it is not necessarily possible to make a direct comparison between the results from each frequency range; but there does appear to be reasonable agreement in regions of overlap.

The low-frequency range has been chosen for a detailed investigation of the effects of frequency and physical structure on the glass–rubber transition using a constant strain amplitude of 0·7 per cent. The load-extension loop is an ellipse, the slope of the major axis and the width being determined by the Young's modulus and the phase difference between the load and the applied extension (loss angle). The temperature dependence of these two quantities is used to determine the position and nature of the transition.

For all the yarns tested, the modulus decreases with increasing temperature, and the resultant tension becomes increasingly out of phase with the applied extension, until the foot of the sigmoidal modulus–temperature curve is reached, when the phase difference decreases again. In undrawn, amorphous filaments, this 'glass–rubber' transition is sharply defined by a drop of a factor of 100 in Young's modulus, whereas drawn crystalline filaments have a much broader transition with only a fourfold drop in modulus, occurring at a higher temperature.



The effect of increasing frequency is to increase the modulus and change the loss angle in the transition region, so that the maximum loss angle occurs at a higher temperature. For undrawn amorphous or slightly crystalline filaments this shift in loss peak is about 3·5° C. per decade, corresponding to an apparent activation energy of 170 k.cal./mole, whereas for highly crystalline drawn filaments the figures are 7° C. per decade and 90 k.cal./mole.

Increasing the crystallinity of undrawn yarn results in a broadening of the loss angle curve and a shift of its peak towards higher temperatures, together with a considerable reduction in its peak value, while the Young's modulus at temperatures above the transition region is considerably increased. The curves are further modified in a similar way in the more highly crystalline drawn yarn, the relative data being given in the accompanying table. This briefly summarizes the major influence of orientation and crystallization upon the physical properties; the two effects, however, cannot be completely separated owing to their close interdependence. The diagram shows the effect of crystallinity and orientation on the loss angle–temperature curves.

It is hoped to publish this work in more detail elsewhere.

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Magnetic Susceptibility of Vanadium Dioxide

We have found that the reduction of vanadium pentoxide (V_2O_5) as described below gives a form of vanadium oxide (VO_2) which has not the magnetic discontinuity (at 341° K.) reported in the literature[1,2].

Reduction of vanadium pentoxide, prepared from 'Analar' ammonium metavanadate, with hydrogen below 530° C. yields a blue-black powder. Oxide compositions in the range $VO_{1\cdot98}$ to $VO_{2\cdot3}$ have been prepared in this way and their magnetic susceptibilities measured in a nitrogen atmosphere. The compositions were checked from (i) the loss in weight on reduction from the pentoxide, (ii) the quantity of hydrogen used in reduction, and (iii) by titration with permanganate before and after measurement.

The oxides were examined in the range 20°–450° C. and the values of mass susceptibility χ_m of the vanadium oxide present, assuming them to be mix-

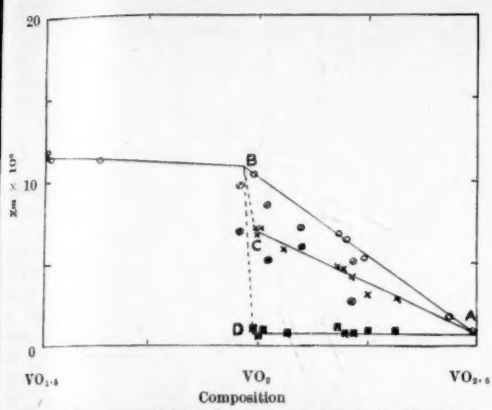

Fig. 1. Mass susceptibility of vanadium oxides. ○ (no discontinuity), at 340° K.; ⊕ and ◎, at 335° K., 345° K., respectively (discontinuity at 340° K.). The line *AB* fits the points ○. Results for sintered oxides. □, (at 335° K.) and × (345° K.) for the various compositions. Lines *AD* and *AC* fit these points fairly well

tures of VO_2 and V_2O_3, were plotted for each oxide and above 345° K. were found to obey the Curie–Weiss law:

$$\frac{1}{\chi_m} = \frac{T - \theta}{C_M} .$$

Only slight discontinuities were noted at 340° K., and the values of θ and p_B (derived from C_M) for the V^{4+} ion were in the ranges $\theta = -350°$ to $-450°$ K. and $p_B = 1{\cdot}8$ to $2{\cdot}2$ Bohr magnetons for observations above 345° K. The results are plotted in Fig. 1.

These values were not inconsistent with the theoretical value of $p_B = 1{\cdot}73$ for the spin only state of V^{4+}.

The actual values of χ_m were generally too high (for example, $VO_{1.99}$, $\chi_m = 9{\cdot}15 \times 10^{-6}$ at 335° K.; $11{\cdot}15 \times 10^{-6}$ at 345° K.; and $VO_{1.8}$ $\chi_m = 13{\cdot}9 \times 10^{-6}$ at 335° K.) for these oxides to be mixtures of V_2O_3 and V_2O_4. They show no ferromagnetism.

When the oxides $VO_{2.2}$–$VO_{2.3}$ were fused at 750° C. in nitrogen, or V_2O_3 and V_2O_5 were fused together in the appropriate proportions at 750° C. in nitrogen, in a sealed silica tube, the resulting crystalline oxides had large discontinuities in susceptibility at 341° K. similar to, but more pronounced than, those reported by Perakis and Wucher[2]. The susceptibility curves were exactly reversible on cooling down again through 341° K. The V^{4+} ions in these oxides gave $\theta = -1{,}200°$ to $-1{,}400°$ K. and $p_B = 2{\cdot}8$–$3{\cdot}1$ Bohr magnetons, above 345° K. The value of $p_B = 3{\cdot}0$ corresponds to the presence of an unquenched orbital contribution in addition to the spin contribution. The values of χ_m for $VO_{2.00}$ were $1{\cdot}2 \times 10^{-6}$ at 335° K. and $7{\cdot}75 \times 10^{-6}$ at 345° K. with the main discontinuity at 341 ± 2° K. The results for sintered oxides are plotted in Fig. 1.

The existence of a sharp increase in electrical conductivity and a decrease in thermoelectric e.m.f. (cold junction negative throughout), when the temperature rises from 330° to 350° K., has been noted for the fused $VO_{2.00}$. No sharp changes in these properties have been observed for the powder form of this oxide.

These results suggest the existence of two different forms of VO_2, depending on whether the oxide has been sintered during preparation or not. This is in line with the results of Flood and Kappa[3] on vanadium oxide prepared by sulphur dioxide reduction of the pentoxide. We are unable to agree with these authors that VO_2 is formed in this latter process, as samples we have prepared at 480°–640° C. all analysed as $V_{13}O_{26}$ (allowance being made for any sulphur dioxide adsorbed on the final oxide). Rate measurements indicated that some sintering occurred between 600° and 640° C., however.

It would appear that oxygen can be removed from the V_2O_5 lattice until the composition VO_2 is formed; but the rutile structure is not attained unless the temperature is raised above about 620° C.

The results of Perakis and Wucher[2] suggest that the oxide they examined was a mixture of the two phases, and the non-reversible curve obtained on cooling after heating suggests either oxidation or a change in the proportions of the two phases. All our curves were reversible on cooling, except when the measurements were extended above 400–450° C. (in nitrogen).

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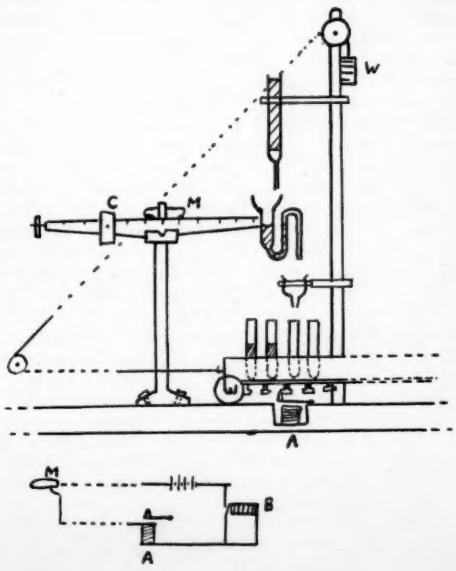
Simple Automatic Fraction Cutter

The automatic fraction cutter described below is of extremely simple design and inexpensive to make, and yet works as efficiently as any commercial model. In contrast to those which have been described previously[1,2], where a twisted string provided motive power, this cutter uses a descending weight, which is not only more dependable but also can be readily adjusted.



The column delivers into a small siphon attached to one end of a balance beam, and a counterweight C on the other side of the beam is used for adjustment. A mercury switch clipped to the top centre of the beam makes contact when the weight of liquid in the siphon tilts the beam. At the moment contact is made, a relay A underneath a trolley of test tubes is operated, and a lagged relay B, taking small current, switches this off very quickly afterwards. The trolley is moved along one division in this time by a weight, W, and pulley system. The siphon empties shortly after this, thereby releasing relay B; but this simply switches off the current and there is no movement of the trolley. During this time, and while the siphon is refilling, any last drips from the siphon are collected in the same tube.

The trolley in use has only sixteen holes drilled for test tubes spaced $1\frac{1}{4}$ in. apart. The design of the trolley may easily be modified to take more tubes or even flasks if a larger volume is required. Beneath the holes a strip of $\frac{1}{8}$-in. steel has been drilled and tapped for 16 6.B.A. 'cheesehead' bolts which connect with the catch of relay A.

The volume that the siphon delivers can be adjusted with glass beads, and the counterweight moved accordingly.

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Measurement of Small Differential Pressures at Low Absolute Pressures

In the course of a study of the flow of gases through powders at reduced pressures, it was necessary to be able to measure pressure differences of the order of 1–60 microns mercury in the absolute pressure range 1–100 microns mercury. Such small pressure differences have been measured by using two McLeod gauges, and the method has been reported elsewhere[1]. It was found that pressure differences of a small order could not be accurately measured using two separate McLeod gauges, even when a cathetometer was used for reading the mercury levels. Consequently, an alternative method and apparatus were developed and their principles are described here.

The apparatus (Fig. 1) consists basically of two McLeod bulbs connected on each end of a capillary oil manometer. The pressure difference applied between A and B is initially shown as a minute difference in the levels of the manometer filled with high-vacuum oil. Mercury contained in the reservoirs driven by the atmospheric pressure fills the bulbs and encloses the volumes of gas above the level YY. The final mercury level is reached at XX (approximate height of mercury 76 cm.). Thus the gas which originally occupied the bulbs and capillary tubes up to the level XX is compressed into the capillary manometer tubes above the oil. In the apparatus built in our experiments the compression ratio was about 20 : 1, thus increasing the observed differential pressure about twenty times, which was easily read with the cathetometer.

A simple theory of this apparatus is as follows. Let the actual pressure drop be $\Delta p = P_A - P_B$.

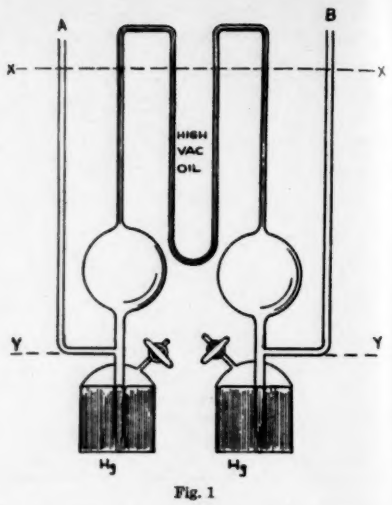

Fig. 1

Left-hand side : V_1 = volume of bulb + capillary between the levels XX and YY.

V_2 = volume of capillary between XX and oil level.

Right-hand side : V_3 = volume of bulb + capillary between the levels XX and YY.

V_4 = the volume of capillary between XX and oil level.

When the gas is compressed by raising mercury into the bulbs and up to the level XX, the following relation applies :

$$P_A (V_1 + V_2) = P_A' V_2 ; \text{ that is, } P_A' = \frac{V_1 + V_2}{V_2} P_A$$

$$P_B (V_3 + V_4) = P_B' V_3 ; \text{ that is, } P_B' = \frac{V_3 + V_4}{V_3} P_B$$

If $V_3 \approx V_2$ and $V_4 \approx V_1$ and $V_2 \ll V_1$;

$$\Delta p' \approx \frac{V_1}{V_2} \Delta p.$$

Hence the actual pressure drop Δp can be magnified by the ratio of the volumes of the bulb to that of the capillary manometer.

When $(V_3 - V_2)$ and $(V_4 - V_1)$ are not zero, then a plot of $\Delta p'$ versus Δp at different values of P_B will give the value of the expression :

$$\frac{(V_3 - V_2) + (V_4 - V_1)}{V_2} .$$

The differential pressures at low pressure may thus be obtained either from the final equation or from a graph and converted into the mercury readings applying the known density ratio of mercury to the oil.

In order to ensure complete pressure equilibrium, a period of $\frac{1}{2}$–1 hr. was allowed to lapse between the compression of the gas and the final measurement of the oil levels. The method itself gives very reproducible results and is simple in operation.

D. I. Gaffee
A. G. Monroe

Research and Development Dept.,
British Oxygen Co., Ltd.,
Morden Road,
London, S.W.19. July 9.

[1] Knudsen, *Ann. Phys.*, **28**, 999 (1909).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 18

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Electricity in the Future".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. N. Fleming: "Techniques for Objective Noise Measurement".

INSTITUTE OF METAL FINISHING (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Dr. R. E. Kressman: "Ion Exchange in the Metallurgical Industries".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at Dartford Technical College, Dartford), at 7.30 p.m.—Mr. W. S. Wood: "Manufacture and Uses of Hydrogen Peroxide".

Tuesday, October 19

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. H. E. Lewis: "The British North Greenland Expedition, 1952–54".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. F. H. Allen, Mr. W. A. Price and Sir Claude Inglis, F.R.S.: "Model-Experiments on the Storm Surge of 1953 in the Thames Estuary and the Reduction of Future Surges".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. M. Whitehead: Chairman's Address.

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (in the Beveridge Hall, Senate House, London, W.C.1), at 5.30 p.m.—Prof. A. V. Hill, F.R.S.: "Why Biophysics?" (From a series of lectures on "The Scientific Basis of Medicine".)*

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. C. H. Bamford: "Recent Investigations in the Field of Vinyl Polymerization".

INSTITUTION OF MECHANICAL ENGINEERS, STEAM GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Measurement of the Wetness of Steam".

ROYAL SOCIETY OF MEDICINE, PATHOLOGY SECTION (at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Prof. L. P. Garrod: "Chemicals versus Bacteria" (Presidential Address).

Wednesday, October 20

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. H. Harris: "Biochemical Genetics".*

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Scientific Papers.

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Sir Weldon Dalrymple-Champneys: "Non-specific Physiological Factors Controlling the Phenomena of Parasitism" (Presidential Address).

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. S. Chandrasekhar: "Infant Mortality in India, 1901–1951—a Demographic Revolution".*

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. J. N. McArthur: "A Contribution to Microscope Design".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 7.45 p.m.—Mr. Engel Lund and Mr. Ferdinand Rauter: "Folk Songs of Many Lands".*

Thursday, October 21

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. P. E. Hodgson: "Nuclear Disintegration".*

PHYSICAL SOCIETY and the INSTITUTE OF PHYSICS (at the Research Laboratories of the General Electric Co., Ltd., Wembley), at 2 p.m.—Joint Colloquia on "Modern Materials for Thermionic Cathodes".

MEDICAL RESEARCH COUNCIL (at the National Institute for Medical Research, Mill Hill, London, N.W.7), at 5 p.m.—Dr. J. H. Hanks (Harvard Medical School, Boston): "The Application of Metabolic Study to Leprosy Research".

INSTITUTE OF REFRIGERATION (joint meeting with the Low Temperature Group of the Physical Society, at the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. N. P. Allen: "The Properties of Metals at Low Temperatures".

UNIVERSITY OF LONDON (at Birkbeck College, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. R. S. Krishnan (Bangalore): "Colloid Optics" (University Lectures in Physics. Further Lectures on November 24 and 25).*

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. B. S. Platt: "Protein Malnutrition". (From a series of lectures on "The Scientific Basis of Medicine".)*

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. P. M. Davidson: "The Manufacture and Applications of Glass in the Building Industry".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. R. B. Heisch: "Epidemiology of an Outbreak of Kala-azar in Kenya".

TEXTILE INSTITUTE (at 10 Blackfriars Street, Manchester 3)—Symposium on Transactions Papers.

Friday, October 22

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. D. W. van Krevelen (Holland): "Heterogeneous Reaction Processes. 2: Gas-Solids Reaction Processes".*

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (joint meeting with the LONDON SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the Physical Chemistry Laboratory, South Parks Road, Oxford), at 7.15 p.m.—Dr. J. E. Johnston: "Assay Equipment for a Radiochemical Laboratory"; Dr. D. E. Palin: "The Determination of Gamma Isomer in Crude Benzene Hexachloride by a Carbon-14 Isotope Dilution Method"; Mr. R. H. Burns: "The Physical and Analytical Control of the Radioactive Effluent from A.E.R.E., Harwell".

Saturday, October 23

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (at the Institute of Education, Malet Street, London, W.C.1), at 2.30 p.m.—Mr. G. T. Sare: "Cybernetics and Teaching".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Kenneth P. Oakley: "Piltdown Man".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with an honours degree in mining and preferably with practical experience in the mining industry) IN MINING ENGINEERING—The Registrar, The University, Nottingham (October 23).

MATHEMATICIAN (with a good honours degree, and preferably with some practical experience in the design of experiments), to design and analyse laboratory and small-scale plant experiments—The National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting TT/851 (October 23).

SCIENTIFIC OFFICER (with a good honours degree in botany or agricultural botany) at the hill research farm of the Hill Farming Research Organization, Sourhope, Roxburghshire—The Secretary, Hill Farming Research Organization, Broomhouse Drive, Edinburgh 11 (October 23).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree or at least the general certificate of education at advanced level) IN THE PLANT BREEDING SECTION—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (October 25).

LECTURER (with a good honours degree) IN PHYSICS, and a LECTURER (with a good honours degree) IN BOTANY, at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (October 25).

LECTURERS (2) (with a good honours degree) IN PHYSICS at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (October 25).

ASSISTANT LECTURER (with special qualifications in pure mathematics) IN MATHEMATICS—The Registrar, The University, Manchester (October 30).

LECTURER IN THE DEPARTMENT OF CLINICAL CHEMISTRY—The Secretary, The University, Edinburgh (October 30).

LECTURER (with a degree in engineering and preferably with experience or interest in some aspect of heavy power electrical engineering such as modern methods of system analysis or some aspects of electrical design) IN ELECTRICAL ENGINEERING, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London (Australia, October 30).

NATIONAL RESEARCH DEVELOPMENT CORPORATION SCHOLARSHIP tenable in the Computing Machine Laboratory—The Registrar, The University, Manchester (October 30).

LECTURER IN ANTHROPOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, October 31).

ASSISTANT LECTURER IN BACTERIOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (November 1).

ASSISTANT LECTURER (with an honours degree with good qualifications in agricultural chemistry, chemistry or biochemistry, and preferably with previous experience of teaching or research in soil science) IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Reading (November 1).

CHAIR OF ISLAMIC ARCHÆOLOGY—The Dean, Faculty of Arts, Cairo University, Cairo (November 1).

CHAIR OF ANIMAL HUSBANDRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, November 6).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with a degree in veterinary science and postgraduate research experience in bacteriology or immunology, or equivalent qualifications) AT THE ANIMAL HEALTH RESEARCH LABORATORY, Commonwealth Scientific and Industrial Research Organization, Parkville, Victoria, to carry out researches on approved aspects of bovine contagious pleuro-pneumonia and to take over the supervision of bovine production—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 201/74 (November 6).

ASSISTANT LECTURERS (with special qualifications in physical chemistry) IN CHEMISTRY—The Registrar, The University, Manchester (November 13).

LECTURER (graduate with some experience of teaching, and preferably with a higher degree suited to the training of teachers) IN EDUCATION, at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, November 15).

SENIOR LECTURER IN PHYSICAL CHEMISTRY at Canterbury University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, November 15).

SENIOR LECTURER IN PHYSICS at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Hong Kong, November 30).

BIOCHEMIST (Senior grade) (preferably with experience of recent methods used in general medical clinical biochemistry)—The Medical Superintendent, Morriston Hospital, Swansea.

BRADFORD DYERS' ASSOCIATION RESEARCH FELLOW (with high qualifications in science) to undertake research in tinctorial chemistry, textile chemistry, or an allied subject—The Principal, Technical College, Bradford 7.

CHEMISTS (with an honours degree in chemistry, chemical engineering, A.R.I.C., A.M.I.Chem.E. or equivalent qualifications), at Windscale Works, Sellafield, Cumberland, to undertake experimental work on chemical and chemical engineering problems in connexion with the development of new chemical processes—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 676.

ELECTRONIC ENGINEER or PHYSICIST, to assist in installation and operation of an electronic digital calculator—The Secretary, Birkbeck College, Malet Street, London, W.C.1.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (graduate in physics or chemistry) required for the Soil Survey of England and Wales, to work on clay mineralogy by X-ray and thermal methods—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

HYDROLOGISTS (with an honours degree in applied science or engineering and at least two years postgraduate experience) in the Public Works Department, Kenya, for investigations of surface and underground water resources, including stream gauging, studies of rainfall and run off, and of ground water reservoirs, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.112/7/01/T.

JUNIOR LECTURER (graduate in science, agricultural science or horticultural science) IN INORGANIC CHEMISTRY AND SOIL SCIENCE at Massey Agricultural College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

MECHANICAL ENGINEERS, AERODYNAMICISTS, PHYSICISTS, an ELECTRICAL ENGINEER, a CHEMICAL ENGINEER, and a MATHEMATICIAN (with a first- or second-class honours degree or equivalent qualification in an appropriate subject) at the Ministry of Supply National Gas Turbine Establishment, near Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.272/54A.

METALLURGIST (with an honours degree in metallurgy, A.I.M., or equivalent, and with considerable industrial experience, preferably in both the ferrous and non-ferrous fields), to advise on all metallurgical problems arising in the design, manufacture and inspection of specialized plant, including nuclear reactors, and to maintain liaison between design offices, other headquarters groups, and various research and development laboratories—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 685.

PHYSICIST (with a first- or second-class honours degree or equivalent in physics) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for the design of high temperature electronic components for guided weapons, for use under severe vibration and climatic conditions—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.265/54A.

PHYSICIST (with a good honours degree in physics and at least two years research experience, and ability to extract information from laboratory records, repeat experiments and write suitable articles for the technical press)—The Delawarr Laboratories, Oxford.

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMICAL ENGINEERING to investigate certain aspects of the inflammability of gases—Dr. J. H. Burgoyne, Imperial College of Science and Technology, London, S.W.7.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in physics, electrical engineering or mathematics) at the Royal Aircraft Establishment, Farnborough, Hants, for theoretical and experimental work on flight instruments for high speed aircraft, and investigations into stability and control of aircraft when flown with automatic pilots, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.264/54A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Parliamentary and Scientific Committee. Memorandum on Higher Technological Education. Pp. 16. (London: Parliamentary and Scientific Committee, 1954.) 2*s*. [267

Institution of Chemical Engineers. Regulations for the Admission of Student, Graduate, and Corporate Members, and for the Examination of the Institution. Pp. 20. (London: Institution of Chemical Engineers, 1954.) [267

Discovery Reports. Vol. 26: The Bathypelagic Angler Fish *Ceratias Holbölli* Krøyer. By Robert Clarke. Pp. 1–32+plate 1. 6*s*. net. Vol. 26: Stylasteridae (Hydrocorals) from Southern Seas. By Hjalmar Broch. Pp. 33–46+plates 2–4. 6*s*. net. Vol. 26: Antarctic and Subantarctic Mollusca: Pelecypoda and Gastropoda. By A. W. B. Powell. Pp. 47–196+plates 5–10. 30*s*. net. Vol. 26: The Vampyromorpha of the Discovery Expeditions. By Grace E. Pickford. Pp. 197–210. 3*s*. net. Vol. 26: Discovery Investigations—Station List R.R.S. *William Scoresby* 1950. Pp. 211–258+plates 11 and 12. 12*s*. net. Vol. 26: A Preliminary Report on the Ostracods of the Benguela Current. By E. J. Iles. Pp. 259–280. 9*s*. net. Vol. 26: Dispersal in Blue and Fin Whales. By S. G. Brown. Pp. 355–384. 12*s*. 6*d*. net. Vol. 26: Title Page and List of Contents. Pp. vi. 2*s*. net. (Cambridge: At the University Press, 1950–1954.) [267

National Physical Laboratory. Automatic Digital Computation. (Proceedings of a Symposium held at the National Physical Laboratory on March 25, 26, 27 and 28, 1953.) Pp. vi+296 (13 plates). (London: H.M. Stationery Office, 1954.) 21*s*. net. [267

Committee of Privy Council for Medical Research. Report of the Medical Research Council for the year 1952–1953. Pp. v+269 (Cmd. 9184.) (London: H.M. Stationery Office, 1954.) 7*s*. 6*d*. net. [267

Air Ministry—Meteorological Office. Professional Notes. No. 113: Classification of Upper Air Temperature According to Tropopause Pressure. By J. K. Bannon. Pp. 20. (M.O. 5241.) (London: H.M. Stationery Office, 1954.) 9*d*. net. [307

The Shortage of Science Teachers. (Report of an independent committee set up by resolution of the Conference convened by the Federation of British Industries in January, 1954.) Pp. 23. (London: Federation of British Industries, 1954.) 1*s*. 6*d*. [307

National Physical Laboratory. Notes on Applied Science No. 7: Balances, Weights and Precise Laboratory Weighing. Pp. iv+46+2 plates. (London: H.M. Stationery Office, 1954.) 2*s*. net. [307

Other Countries

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Series, Band 5, Nr. 2: Meridian Observations of Miscellaneous Stars—Observations of Stars contained in Bosa' General Catalogue, Stars Connected with Galactic Nebulæ, and Variable Stars, made with the Repsold Meridian Circle of the Lund Observatory during the years 1939–44, and reduced to the equinox of 1950. By Sven Cederblad. Pp. 34. (Stockholm: Almqvist and Wiksells Boktryckeri AB.; London: H. K. Lewis and Co., Ltd., 1954.) 5.25 kronor. [207

Organisation of Applied Research in Europe, the United States and Canada. Report of Technical Assistance Missions Nos. 81–82–83. Vol. 1: A Comparative Study. Pp. 80. 6*s*.; 1 dollar; 300 French francs. Vol. 2: Applied Research in Europe. Pp. 192. 12*s*.; 2 dollars; 600 French francs. Vol. 3: Applied Research in the United States and Canada. Pp. 120. 8*s*.; 1.25 dollars; 400 French francs. (Paris: Organisation for European Economic Co-operation; London: H.M. Stationery Office, 1954.) [207

Sudan Government: Ministry of Agriculture. Bulletin No. 11: Commercial Horticulture in the Sudan. 2: Mango Cultivation. By L. B. Thrower. Pp. 66+6 plates. 25 p.t. Memoirs of Field Division. No. 3: Pasture Management in Uganda in Relation to Western Equatoria. By J. R. Catford. Pp. 5. No. 4: A Note based on Field Experience in Planning Hafir Excavation Programmes. By J. H. K. Jefferson. Pp. 22. (Khartoum: Agricultural Publications Committee, 1952–1954.) [237

Arid Zone Programme. Reviews of Research on Problems of Utilization of Saline Water. Pp. 96. (Paris: United Nations Educational, Scientific and Cultural Organization; London: H.M. Stationary Office, 1954.) 1.75 dollars; 10*s*. 6*d*. net; 500 French francs. [237

Philips Serving Science and Industry. Vol. 1, No. 1 (January, 1954). Pp. 32. (6 issues per volume. 25*s*.) (Eindhoven: N.V. Philips' Gloeilampenfabrieken, 1954.) [237

Commonwealth of Australia. Fifth Annual Report of the Commonwealth Scientific and Industrial Research Organization, for the year ending 30th June, 1953. Pp. 191. (Canberra: Government Printer, 1953.) 11*s*. [237

Uganda Protectorate. Annual Report of the Geological Survey Department for the year ended 31st December, 1953. Pp. ii+32. (Entebbe: Government Printer, 1954.) 1/50 *shs*. [267

British Territories in Borneo. Annual Report of the Geological Survey Department for 1953. By F. W. Roe. Pp. v+127+21 plates. (Kuching, Sarawak: Government Printer, 1954.) 3 Malayan dollars; 7*s*. [267

Western Australia. Report of the Government Chemical Laboratories for the year 1951. Pp. 13. (Perth: Government Printer, 1954.) [267

Chicago Natural History Museum. Fieldiana: Anthropology. Vol. 42: Caves of the Reserve Area. By Paul S. Martin, John B. Rinaldo and Elaine Bluhm. Pp. 227. (Publication 731.) (Chicago: Chicago Natural History Museum, 1954.) 5 dollars. [267

Metropolitan Life Insurance Company. Statistical Bulletin Vol. 35, No. 6: Hazards in Competitive Athletics. Pp. 12. (New York: Metropolitan Life Insurance Company, 1954.) [267

Bernice P. Bishop Museum. Bulletin 211: Neogene Smaller Foraminifera from Lau, Fiji. By Robert M. Kleinpell. Pp. iii+96+10 plates. Bulletin 213: Ethnobotany of the Gilbert Islands. By Katharine Luomala. Pp. v+129. Occasional Papers. Vol. 21, No. 9 (February 25, 1954): Ferns of Rotuma Island: a Descriptive Manual. By Harold St. John. Pp. 161–208. (Honolulu: Bernice P. Bishop Museum, 1953 and 1954.) [267

New Zealand. Department of Scientific and Industrial Research: Geophysics Division. Amberley Observatory. Magnetic Results for 1951. Pp. iii+54. (Wellington, N.Z.: Government Printer, 1954.) [267

University of Indonesia: Faculty of Agriculture, Bogor. Communications of Division of Social Sciences. Population and Economic Progress. By Prof. J. P. van Aartsen. Pp. 26. (Bogor: University of Indonesia, 1954.) [307

Bibliography of Scientific Publications of South Asia (India, Burma, Ceylon). No. 9: January–June, 1953. Pp. ii+174. (New Delhi: Unesco, South Asia Science Co-operation Office.) [307